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Nagaratna Biradar
ICAR-Indian Grassland and Fodder Research Institute Southern Regional Research Station, Dharwad, Karnataka, India

Laxmi Tirlapur
ICAR-Indian Grassland and Fodder Research Institute Southern Regional Research Station, Dharwad, Karnataka, India

Akshata Kerur
ICAR-Indian Grassland and Fodder Research Institute Southern Regional Research Station, Dharwad, Karnataka, India

Bheemappa A
Department of Agriculture Extension, UAS, Dharwad, Karnataka, India

Corresponding Author:
Nagaratna Biradar
ICAR-Indian Grassland and Fodder Research Institute Southern Regional Research Station, Dharwad, Karnataka, India

Scientific rationality of indigenous crop management practices of two agro-ecological zones of Karnataka

Nagaratna Biradar, Laxmi Tirlapur, Akshata Kerur and Bheemappa A

Abstract
Indigenous information systems are dynamic and this knowledge system is usually not found in written form and is transmitted from generation to generation through word of mouth. It was built up on farmer's own knowledge generated over centuries, unlike modern technologies, which are exogenous. The present study was aimed at collecting crop management Indigenous Technical Know-how (ITK) followed by farmers and to test their scientific rationality. Present study was undertaken in zone-8 (Northern transitional zone) and zone-9 (Hilly zone) of Karnataka. ITKs related to crop management were collected through checklist guided discussions in 8 villages. Thirty agronomists were consulted to know the scientific rationality of collected ITKs. Results were analyzed using chi-square to know whether sampled agronomists opinion about ITKs match with that of population of experts or there exist any difference of opinion towards the ITK. Seven ITKs (2C, 3C, 5C, 6C, 17C, 18C and 19C) were categorized as highly rational and four ITKs (8C, 10C, 12C and 13C) as least rational. Experts expressed multiple opinions about ITKs 1C, 2C, 5C, 6C, 8C, 13C and 18C thus indicating difference between sampled experts with that of population.

Keywords: crop management, ITKs, rational

Introduction
The indigenous technical knowledge is the localized knowledge, transmitted from generation to generations and time tested by local community to solve the particular problems taking cognizance of local factors. Indigenous information system is dynamic and this knowledge system is usually not found in written form and is transmitted from generation to generation through word of mouth [22, 25]. This knowledge is based on many generations of insights gained through their close interaction with the natural and physical micro-environment [7]. It is constantly influenced by internal creativity and experimentation as well as by contact with external systems [2]. ITKs are derived from practical and innovative life of the generations [40]. The ITK in agriculture are organic in nature [9]. They do not harm any agricultural resources and environment. It was built up on farmer's own knowledge generated over centuries, unlike modern technologies, which are exogenous [10]. The development of modern agricultural technologies, substantially increased the crops and livestock production, but gradually decreased the farms income due to heavy investment on costly external resources of uncertain future availability [11]. The modern agricultural technologies like, monoculture caused rapid erosion of crops and livestock genetic diversity, natural soil fertility and pest's outbreaks, while chemical inputs caused environmental pollution and chemical hazards. So there is a need to minimize this exploitation for safe hand over of agricultural resources to the next generations. Sustainable transfer of resources, especially when a climate change is reality, could be possible by encouraging scientifically rational ITKs. Hence a present study was conceptualized and carried out.
Looking to the importance of the role of farmer's knowledge in sustainable agriculture, an effort has been made to conduct a study on crop management practiced by the farmers and to test their scientific rationality.

Methodology
Approach: An exploratory social science study approach was used to collect data from farmers. Such approaches are used when there is no need to collect multiple views on the issue under study.

Selection of study area: As study focused on farm practiced crop management practices in that area prone for climate variance, selection of study area was made using rainfall data. Taluk wise rainfall data of two agro-climatic zones (Zone-8 Northern Transition zone and Zone-9 Hilly zone) for 30 years period 1989-2018 was collected from Karnataka State Natural Disaster Monitoring Centre, Bengaluru. Using this data, percent deviation from normal rainfall was computed by using the formula

$$\text{Percent Rainfall deficiency} = \frac{100(\text{Averageannualrainfall} - \text{Annualrainfall})}{\text{Averageannualrainfall}}$$

In Zone-8, out of 11 talukas, Savanur taluk experienced consecutive 4 years drought with rainfall deficiency of -36.34 (2015), -50.50 (2016), -35.52% (2017) and -31.62% (2018). So for Zone-8 Savanur taluk was selected for the study. Among talukas belong to hilly zone (Zone-9), Khanapur taluk was selected as it experienced excess rainfall consecutively for three years (+47.77% 2015, +29.15% 2016, +42.98% 2017). Hobli level rainfall data of selected talukas for last four years was collected from Kunimellihalli rain gauge station (Savanur) and Amagoan rain gauge station (Khanapur). Based on higher rainfall deviation four villages each in Savanur (Kunimellihalli, Huralikoppi for rainfed and Mannangi, Mellagatti for irrigation) and Khanapur (Jamboti, Abbanatti, Bailur and Devachhatti) were selected.

Documentation of ITK's: Checklist based on a very exhaustive review of literature was prepared to collect ITK's. Questions in checklist were aimed at understanding the traditional practices followed by farmers in crop management. Totally checklist had 25 questions. For collecting ITKs, facilitators of state agriculture department who work at village level and most of them basically hail from villages were contacted. They were briefed about the purpose of the study. With their help, group discussions in each selected villages were organized. Only those farmers who are above 50 years were involved in the group discussions. These discussions were guided by checklist and the ITKs emerged in discussions were documented. Approximately 25 farmers in each group (village) participated in the discussions. So across 8 villages around 200 farmers were part of the discussions. After the discussion, visit to some of the fields practicing these ITKs were made to see the actual practices of ITKs and to get further information from them.

Data on scientific rationality of ITK's: List of collected ITKs on crop management practices was prepared. Totally 16 ITKs were considered for scientific rationality analysis. There were past studies documented on crop management practices. Three ITKs from the past studies were considered based on the similarity with crops and geographical condition of the study area. So totally 19 ITKs on crop management practices were studied. A questionnaire containing list of these 19 ITKs was prepared to assess the scientific rationality of ITKs. This questionnaire was administered to 30 scientists in the field. These scientists were drawn from State Agricultural Universities located at Dharwad, Bagalkot, Raichur *etc*. Against each ITK scientist had to give responses in terms of percentage based on extent of ITK considered as scientifically rationale along with the reasons for their responses.

Data analysis: ITKs were grouped under three categories as highly scientific, moderately scientific and less scientific by using group mean and standard deviation. ITK falling under each category was listed and presented in tabular form.
Collected data was at interval level of measurement. But had a scientists sample size of 30 (n=30). Box plot diagram of scientists' responses of each ITKs were drawn to know the variation in the responses. It was found that data had lot of variation. So to know whether responses obtained from sample group are in agreement with the population, one-sample
chi-square test was calculated using SPSS version 22. Null hypotheses of ITKs having chi-square value with P ≥0.5 are accepted.
Hypotheses of the present study are as follows
H_o: There is no difference between responses of sample scientists with that of population
H_1: There is a difference between responses of sampled scientists and population.
Here, population represents all those scientists having expertise in crop management.

Results and Discussion

Table 1: Chi-square analysis for crop ITKs

Sl. No.	ITKs	Chi-square	df	p-value
1C	During severe cold in winter, *rabi* crops yield good returns. When Maldandi sorghum is at three to five leaf stages, dew droplets melt due to cold and get enter into stem through shoot by which water is supplied to the roots. So it yields more.	26.33	12	0.010
2C	Farmer's take up relay cropping by keeping chilli as main crop. They cultivate cotton and horse gram as relay crops in *kharif* to overcome possible yield loss due to climate variability and to get continuous return.	18.66	9	0.028
3C	Earthing up of cashew tree planted in hill slopes to protect it from falling during heavy rains/floods	17.66	12	0.126
4C	Floods lead to early emergence of sugarcane flowers affecting sugar recovery percentage and profit levels. Farmers make provisions to drain out water from sugarcane fields to prevent early emergence of flowers.	12.66	9	0.178
5C	Sorghum, wheat and chickpea are resistant to low temperatures. So these crops are cultivated during *rabi*.	33.33	9	0.000
6C	Magi (August 17- August 30) rain is very useful as it helps to retain moisture and planning for cultivation of *rabi* crops.	33.00	8	0.000
7C	Insect and pest attack incidences increase during Mrugashira rain (June 8 to June 21) but immediately after onset of Magi (Magha) rain (August 17- August 30) the incidence of pest and diseases decreases.	19.40	12	0.079
8C	Farmers carry out sorghum sowing other than Tuesday. Smut infestation is believed to be more if crop is sown on Tuesday.	78.00	5	0.000
9C	Washing the sorghum seeds with water one hour before sowing and shade drying will help to control smut disease and get good crop-stand during drought situation	8.13	12	0.775

10C	Prevalence of heavy frost or frost for few days leads to the infestation of khedda insect i.e. Brown plant hopper (BPH) (*Nilaparvata lugens*) in paddy. To avoid this infestation, salt is applied to affected area of the land in next sowing to control the incidence.	11.60	11	0.394
11C	Soaking of paddy seeds in salt water (1kg of salt per 50 kg of paddy seeds) for 1 hour before sowing and collecting settled grains for sowing will help to withstand low soil moisture and resistance to the pest and disease attack.	9.20	11	0.603
12C	During *kharif* paddy cultivation, farmers is provide small water outlet and place bark of Rameta tree to the each out late of terrace. When water is flow through this bark gets filtered and it acts as an insecticide and reduces the stem borer attack.	9.86	12	0.628
13C	In cotton, to avoid shedding of flowers and bolls due to continuous rain and cold farmers apply 50 ml of castor oil to the plants.	22.80	10	0.012
14C	Farmers irrigate cotton field to minimize the frost effect in the month of September and October.	16.66	13	0.215
15C	Seed treatment of cotton seeds with neem oil and fresh cow dung before sowing and allow it to dry over night to improve crop resistance to diseases, withstand drought and for easy handling of seeds while sowing.	12.66	9	0.178
16C	Severe frost leads to dropping of flowers in cotton. To prevent this farmers prepare solution by mixing neem tree gum in water. To this they add crushed neem leaf extract. This is used to spray cotton crop in the first fortnight of September. Neem leaves and gum solution: mixing of crushed neem leaves, local cow urine and the gum of neem tree are soaked together in a pot for 7 days. The solution is prepared seven days before taking spraying in cotton crop. They add 50 ml of the prepared solution to 16 litres tank. If the shedding is more, they add 100 ml per 16 litres. If the crop height is more about 4-5 feet, they need 5-6 tanks per acre. If the crop is about 2-3 feet height, they in 3-4 tanks per acre of land.	14.20	12	0.288
17C	Farmers practice cropping pattern as mentioned here. Between two rows of chilli, two lines of Jaidhar cotton and between the two rows of cotton one row of horse gram i.e Chilli + Cotton + Horsegram + Cotton + Chilli 2:2:1:2:2 or Chilli + Horse gram + Cotton + Horsegram + Chilli ratio in 1:1:1:1:1 respectively. Growing of horsegram between the rows helps in fixation of atmospheric nitrogen to the main crop which helps in increasing yield in main crop.	12.66	7	0.081
18C	Practice of earthing up in groundnut crop by using local hoe helps in fixation of more pegging in Groundnut.	46.80	7	0.000
19C	Farmers were shifting to maize crop whenever south west or north east monsoons get delayed by one month because of its wide weather adaptability. This practice followed in rainfed conditions.	13.20	8	0.105

Regarding ITK 1C, cold during *rabi* reduces evaporation of moisture from soil and reduces the losses. Moisture is absorbed by foliage. Some of the experts said that sever cold $<10^0$c for continuous 10 days acts adversely on *rabi* sorghum. This ITK depends on size of the water droplet and angle between stem and leaf which makes ways for entry of droplet in to the stem. Cold weather will boost yields of winter-sown or rabi grains, oilseeds and pulses, increasing the country's food output to a new high [30]. Lower temperature over rabi season helps in the phonological development process of *rabi* crops mainly wheat in North west India [34]. Sudden shoot up of air temperatures in early spring when wheat and other winter crops were at reproductive stage of their life cycle caused significant reductions in the grain yield despite affecting the apparent health of the crops [42].

Chilli and cotton as mixed crops along with horse gram as relay crop is taken up (ITK 2C). Horse gram is resistance to drought and it covers land very fast. And if one crop fails another crop will give return. It helps in better utilization of resources. Inter crops have differential root growth, growth pattern, yielding ability and crop duration [26]. Chilli genotypes did not affect the performance of cotton in the chilli+cotton intercropping system [15]. Growing of short duration legume in chilli cotton mixed cropping. Green gram and peas intercropping leads to reduction in yield of cotton and chilli [39]. Earthing up of cashew tree planted in hill slopes to protect it from falling during heavy rains/floods (3C). It is done only at the early years of plantation. It will reduce lodging and give mechanical support. It also helps to protect the plants by entry of pests through collar at ground level. Earthing up to prevent root formation at nodes and to make the originally formed roots to increase in size [48]. Earthing up for 2-3 times helpful in increasing the production of crops by allowing proper crop stand [17]. Based on yield and yield components data, it was concluded that those varieties in which earthing up was made had maximum pods/plant, kernel weight, pods length and pod yield as compared to control variety in case of groundnut [32] and in potato [8].

Floods lead to early emergence of sugarcane flowers affecting sugar and profit levels. Farmers make provisions to drain water from sugarcane fields to prevent early emergence of flowers. High soil moisture leads to vegetative growth and flowering. As under unfavorable condition plants try to complete life cycle early. Removal of excess moisture and good aeration will increase the sucrose content in cane. Excess moisture leads to early maturity. If flowering in sugarcane occurs, this ensures a very high chance that pithing, it can result in reduced sucrose extraction during milling. Wet fields produce more flowers than dry fields and field with higher water tables and nitrogen deficiency yield more flowers in sugarcane [20]. There are several factors affecting flowering including photoperiod, temperature, moisture, age and nutrition [31]. One of the most important factors for flowering is photoperiod and temperature 18-31 ºC leads to flowering [14].

Sorghum, wheat and chickpea are resistant to low temperatures. So these crops are cultivated during *rabi*. These crops require cool temperature for vegetative growth so winter temperature is ideal for these crops. They are not actually resistant instead they adjust to low temperature. Flowering requires longer day length. Similar crops are mentioned in the manual published [13]. These crops come up well based on available moisture. If *kharif* rains are good then *rabi* crops comes up better. They are not dependent on water instead cool climate is sufficient for their growth. Magi (August 17- August 30) rain is very useful it helps to retain moisture and planning for cultivation of *rabi* crops. For this ITK, experts commented that this rain will make soil to hold more moisture in deep and will be used by *rabi* crops. But chances of Magi rain are very rare in some parts. Coefficient of variation in rainfall are comparatively low from Mrigashira (8^{th} June -21 June) to Hasta (27^{th}sep -9^{th} Oct) so it gives some

assurance to farmers of rainfed agriculture [12]. Frequency of above normal rainfall ranged from 9 per cent in Mrigashira to 43 per cent in Purva in Gujarat [44]. It indicates these are the major period annual rainfall occurrence and helps for crop planning. Rohini and Aridra rains are useful for land preparation. Aridhra to Uttara which covers the monsoon period with adequate amount of rainfall during which crops like greengram, blackgram, soybean, redgram, *kharif* sorghum, maize, bajra could be grown [43]. South-West Monsoon in India is a four month occur from June (Mrugashira) till September (Hasta) and >75 per cent of India's annual rainfall occurs during this period [7]. Good rains during the season result in bountiful crops which further benefit the farmers. Rainfall during Mrugashira, Aridhra, Pushya, Makha, Pubba and Chitta had an increasing trend compared to other rains in Hiriyur [28]. The pre-monsoon season extended till Mrugashira (8th June – 21st June) Nakshatra, during which the sowing of crops like cotton, tobacco and ragi in addition other crops can be taken cultivate. The CV of rainfall was highest and mean rainfall was lowest during Mrugashira in GKVK station [29]. Mrugashira and Aridhra Nakshatras received less rainfall during which one can take up crops like finger millet, sunflower, pigeon pea and groundnut.

Insect and pest attack incidences increase during Mrugashira rain (June 8 to June 21) but immediately after onset of Magi (Magha) rain (August 17- August 30) the incidence get decreases. Experts view is intensity of pest depends on intensity and number of days of rainfall. Initial showers break the pupal stage and makes way for entry of life. Due to heavy rainfall in later period will wash away the insects. Usually cloudy weather with humidity enhances pest attack and heavy rain washes them. Good rains during the season result in bountiful crops which further benefit the farmers. Farmers carry out Sorghum sowing other than Tuesday. Smut infestation is believed to be more if crop is sown on Tuesday. This is the wrong assumption of the farmers. Sowing day not *et al*. related with insect infestation. Washing the sorghum seeds with water one hour before sowing and shade drying will help to control smut disease and get good crop-stand during drought situation. It will not reduce smut. But soaking for few hours will induce drought tolerance. Soaking for one hour is not give good results farmers must soak at least for five to six hours before sowing. Smut is seed born disease spores will be washed by water. If it cleans spores then smut infestation will reduce and improves germination. But we cannot wash fungi completely using water. We can only reduce the disease inoculums. Soaking time and germination improved the nutritional properties of sorghum [35]. Soaking seeds in water before sowing gives the germinating seeds a head start and speeds up seed establishment with a corresponding increase in survival rates and yields [18]. Treat the seeds with asafetida solution (75–100 gms in 1 litre of water) and shade dry before sowing. This seed treatment method prevents ergot disease in sorghum. Mix the seeds with the extract of ashwagandha and datura and shade dry before sowing. This will help in the production of healthy and disease free seedlings. Treat the seeds with dried cow dung powder and cow's urine will break the dormancy and improve germination. Soak the seeds in lime water for overnight and dry before sowing [46].

Prevalence of heavy frost or frost for few days leads to the emergence of khedda insect i.e. Brown plant hopper (BPH) (*Nilaparvatalugens*) in paddy. To avoid its infestation, salt is applied to affected parts of the land during next sowing. Fourth instar nymphs have been reported to be more devastating than younger nymphs or adults. Frost forms good condition for emergence of BHP. But salt spray controls the BPH by increasing the temperature in the surrounding. Experts suggested that after salt application soil ph will increase so better to apply bulky organic manure. The brown plant hopper (BPH), *Nilaparvata lugens* developmental period from egg hatching to adult longevity decreases as temperature increased from 19 to 31°C [47]. Months characterized by a climate that is either cold and dry or hot and wet are likely to experience higher levels of BPH whereas other combinations of temperature and rainfall may reduce the abundance of BPH [3]. The rainfall and relative humidity were negatively correlated to the population of BPH whereas temperature was positively correlated to the population of BPH [23, 27]. The rain stopped in last week of September then the population increased with the vegetative stage of crop and reached highest in third week of October [45]. Soaking of paddy seeds in salt water (1kg of salt per 50 kg of paddy seeds) for one hour before sowing and collecting settled grains for sowing will help to withstand low soil moisture and resistance to the pest attack. Experts remarks is soaking seeds in salt water is to get bold and healthy seeds. It will not impart any resistance to pest attack. Settled seeds are fully matured and have high reserve food will helps in early emergence of seedlings. Sowing the seeds soaked in salt water induces tolerance to moisture stress and resistant to pest attack. Similar results and concluded that salt solution can be used to remove the chaffy seeds from good seeds [38]. Take some water in a vessel and drop an egg in it. Keep adding salt to it slowly until the egg reaches the surface of the water. When the seeds are dropped in this water, the good quality seeds will sink into the water. Remove the unviable seeds that float on the surface of the water. Wash the selected seeds in good water for 2 - 3 times to remove the salt deposits. If this is not done, the germination capacity of the seeds will be affected. By this method, the unviable seeds can be removed completely. This method should be followed when there is more of chaff.

In each paddy terrace, farmers provide small water outlet. In this water outlet they place bark of Rameta tree (*Gnidia gluca*). When water is flow through this bark gets soaked and water released from it acts as an insecticide and reduces stem borer attack in paddy fields in *kharif*. It is due to phynoliks and alkaloids present in rameta tree. And other thing is that stem borer decreases due to optimum moisture status. One of such comparatively less explored medicinal plant is *Gnidia glauca*. Although, it has folkloric, traditional phytomedicinal and agrochemical applications in various parts of the world. It is also well known for its piscicidal, insecticidal, molluscicidal and even homicidal activity for its use as arrow poisons (https://newdrugapprovals.org/2015/09/22/14705/). In cotton, to avoid shedding of flowers and bolls due to continuous rain and cold, farmers apply 50 ml of castor oil around cotton plants. This reduces shedding of flowers and bolls. Experts suggested to apply growth regulators to overcome extreme climate condition. Castor oil will not reduce the boll drop / flower drop. Hormonal imbalance, reduction in light penetration, either too much or too little water in the field and excessive high temperature leads to shedding of flowers and bolls [19]. Particular attention should be paid to the interactions of soil fertility, N, moisture supply, and plant population in affecting LAI and light intensity in the plant canopy. Despite their normally beneficial effects, adequate to excess N and soil moisture can decrease boll

setting and yield when plant populations are too high for the conditions. Therefore, plant population should be limited so that spacing is adequate to prevent excessive mutual shading and low light intensity in the canopy. Continuous rain during flowering and boll opening will impair the pollination and may thus reduce boll formation fiber quality [36].

Farmers irrigate cotton field to minimize the frost effect in the month of September and October. Irrigation gives some protection against cold period. Since water has high specific heat, so it helps to protect from frost. But flower drop cannot to reduce completely. It can alter the micro climate by increasing soil temperature and maintain good crop growth. The idea of using irrigation to help prevent dew as water is sprayed in the fields freezes and releases heat to the air as the liquid water changes to ice [37]. The goal is to keep the air temperature in the area at 32 ºF by adding heat in this process. Sprinkling a very low rate of application of water through irrigation can be effective in preventing freeze damage through the release of heat during cooling and freezing [6]. Other frost management processes such as loosing soil surfaces by this process heat conduction process reduce at the surface during night and therefore tend to have lower surface temperatures than compacted soils. Avoid mulching on soil surface (Mulch act as insulator and increases risk of frost). Seed treatment of cotton seeds with neem oil and fresh cowdung before sowing and allow it to dry over night to improve crop resistance to diseases, withstand drought and for easy handling of seeds while sowing. Cowdung and neem oil are very effective. Desi cow dung has crores of beneficial microorganisms. Cow dung is used in preparation of panchagavya which is used for seed treatment. It enhances soil fertility and growth promoter [2]. Neem oil is used in preparation of neemastra which helps useful against sucking pests and mealy bugs. Farmers used materials available in the farm like cow dung slurry, cow urine, common salt, powders of various plant materials, leaf extracts, etc for seed treatment [41]. This helps for good germination, breaking of dormancy, protection against storage pests and diseases, good plant stand, hindering seed ageing, and enhancing the longevity of the seeds. The extracts of *Lantana camara*, neem cake extract, cow urine, *Urtica parviflora*, *Sapium spp*., *Ligustrum nepalensis*, *Eucalyptus spp*. And *Azadirachtin* were found most promising for improved seedling emergence and seedling vigour [21].

Severe frost leads to dropping of flowers in cotton. To prevent this farmers prepare solution by mixing neem tree gum in water. To this they add crushed neem leaf extract. This is used to spray cotton crop in the first fortnight of September. Neem leaves and gum solution: mixing of crushed neem leaves, local cow urine and the gum of neem tree are soaked together in a pot for 7 days. The solution is prepared seven days before taking spraying in cotton crop. They add 50 ml of the prepared solution to 16 litres tank. If the shedding is more, they add 100 ml per 16 litres. If the crop height is more about 4-5 feet, they need 5-6 tanks per acre. If the crop is about 2-3 feet height, they in 3-4 tanks per acre of land. It helps to avoid disease incidence and also urea supplies nitrogen and other micro nutrients helps to retain more flowers. It helps in hormonal balance by it avoids flower drop problem. Using of organic sources for soil application and foliar spray will definitely induce frost resistance in cotton and helps to retain flowers and bolls. Neem acts as good soil conditioner [16].

Farmers practice cropping pattern as mentioned here. Between two rows of chilli, two lines of Jaidhar cotton and between the two rows of cotton one row of horse gram i.e. Chilli + Cotton + Horsegram + Cotton + Chilli 2:2:1:2:2 or Chilli + Horse gram + Cotton + Horsegram + Chilli ratio in 1:1:1:1:1 respectively. Growing of horsegram between the rows helps in fixation of atmospheric nitrogen to the main crop which helps in increasing yield in main crop. Horsegram not only fixes N but it also covers land very fast there by conserving moisture in soil play double benefit to cotton. Always crop diversification with legume is good. Some of the experts said that horse gram may get affected because of some shade effect. Intercropping in various ratios of crops prevailing in that area will be a risk covering practice and including legume crop such as horse gram will fix atmospheric N and reduces cost of fertilizers. Earthing up practices in groundnut crop by using local hoe helps in fixation of more pegging in groundnut. Inter-cultivation helps for aeration, increase water holding capacity and reduce weed growth. It creates easy way for peg penetration. It helps pegs to reach early into the soil and develop into the soil. Due to earthing up in groundnut maximum pods per plant, 100 kernel weight, 20 pods length and pod yield as compared to check variety where no earthing up was applied [33].

Farmers were shifting to maize crop whenever south-west or north-east monsoons get delayed by one month because of its wide weather adaptability. This practice followed in rain fed conditions. Maize crop has more advantageous. Since it is photo insensitive and day neutral in nature it can be grown in any season. Maize requires more nutrients for its development so it should be next followed by pulse crop. Maize crop has a remarkable adaptability in a wide range of climates. It is capable of high levels of production in temperate, subtropical and tropical zones from sea level to high elevation [4, 24].

Table 2: Categorization of ITKs

Highly rational (>73.12)	Moderately rational (73.11 to 54.85)	Least rational(<54.84)
C2 (77.27)	C1 (67.50)	C8 (4.10)
C3 (82.57)	C4 (71.07)	C10 (40.00)
C5 (80.53)	C7 (70.87)	C12 (49.00)
C6 (86.10)	C9 (55.50)	C13 (26.93)
C17(76.03)	C11 (62.83)	
C18 (89.83)	C14 (62.13)	
C19 (79.07)	C15 (71.17)	
	C16 (63.17)	

ITK are categorized into highly rational, moderately rational and least rational ITKs based on the scores given by the experts. Chilli – Cotton+ Horse gram cropping pattern to overcome possible yield loss, Earthing up of cashew tree during heavy rains/floods, Sorghum, Wheat and Chickpea cultivation in *rabi*, Magi (August 17- August 30) rain is very useful for planning *rabi* crop, cropping patter of two rows of chilli, two lines of Jaidhar cotton and between the two rows of cotton one row of horse gram i.e Chilli + Cotton + Horse gram + Cotton + Chilli 2:2:1:2:2 or Chilli + Horse gram + Cotton + Horse gram + Chilli ratio in 1:1:1:1:1, Growing of horse gram between the rows helps in fixation of atmospheric nitrogen to the main crop which helps in increasing yield in main crop. Earthing up in groundnut crop by using local hoe helps in fixation of more pegging in groundnut and farmers were shifting to Maize crop whenever south west or north east monsoons get delayed by one month because of its wide weather adaptability are the highly rational ITKs.

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