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Review Article

Genetic parameters and effect of non genetic factors on lifetime performance traits of Murrah Buffalo: A Review

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ABSTRACT

The success of Indian dairy industry is much dependent on productivity and efficient reproduction performance of Murrah buffaloes. .It is a established fact that first lactation yield is a good indicator of lifetime performance but still there is further need to study the relationship between first, later lactations and lifetime performance traits for overall better evaluation of genetic worth of the female individual's own performance and for ranking of sires. Economic return from dairy animals depends on lifetime performance. The prediction of expected correlated response to selection based on early performance and development of selection schemes for genetic improvement in lifetime traits are likely to be more beneficial. The impact of any selection programme depends upon degree of accuracy of selection and genetic correlation between early and lifetime performance traits. Keeping in view, the above facts available through the literature on this species of livestock indicated immense opportunities for the evaluation of genetic parameters and devising appropriate selection indices. The literature pertinent to genetic and phenotypic parameters of lifetime performance traits viz. number of lactations completed, herd life (days), lifetime milk yield (kg), productive life (days), milk yield per day of productive life (kg/day) and milk yield per day of herd life (kg/day) and non genetic factors affecting lifetime performance traits were reviewed in Murrah buffaloes.

Keywords: *Lifetime traits, Murrah, genetic, phenotypic parameters*

INTRODUCTION

World buffalo population is estimated to be approximately 185.29 million spreading over 42 countries, of which 179.75 million (97 percent) are found in Asia, while approximately 5.54 million are found in rest of the world (FAO, 2008). India, with its 108.70 million heads of Buffalo (BAHS, 2014) has the largest Buffalo population in world, out of which 20% is comprised of Murrah. Although the proportion of buffaloes to cattle is 1:2, buffaloes contribute around 57 percent of the total milk production (DAHD-GOI-2012). The genetic worth of buffalo is primarily determined by her lifetime performance.

This includes the ability to maintain high level of production for a longer period and more number of calving in her lifetime. Although lactation records are widely used in assessing the genetic merit of buffaloes but selection of dairy sires is invariably based on the first one or two lactation records in most of the breeding programmes (Kuralkar and Raheja, 1997). It is a established fact that first lactation yield is a good indicator of lifetime performance but still there is further need to study the relationship between first, later lactations and lifetime performance traits for overall better evaluation of genetic worth of the female individual's own performance and for ranking of sires. First lactation has positive genetic and phenotypic correlations with all other first lactation traits and values varied from low to medium. These results suggested that selection on basis of FLMY would be expected to improve lifetime performance traits in cattle (Singh *et al*. 2008). There are several non-genetic factors which introduce biasness in the estimation of genetic value of performance traits. The non-genetic factors such as management, amount and quality of feed, season etc. also influence milk yield and lactation length, and need to be assessed in a production set up. This will help to formulate suitable evaluation procedures especially in organised farms for improving economic traits of this breed. The literature pertinent to the genetic and phenotypic parameters of lifetime performance traits and non genetic factors affecting can be reviewed as under

Life time traits

The lifetime production performance is a reflection of both productive and reproductive efficiency of farm animal and help in evaluating relative merit and demerits of different breeds maintained under varied agroclimatic conditions. Further, longer herd life increases the total calf crop production and lifetime milk production permitting high intensity of selection. Little information is yet available of lifetime performance of Murrah buffaloes. The averages for life time performance traits of Murrah buffaloes are summarised in Table 1.

(A) Averages of lifetime performance traits and factors affecting lifetime performance traits

1. Number of lactations completed

Varying reports are available in literature on number of lactations considered for definition of lifetime milk production. For example, Kuralkar and Raheja (1997) defined the lifetime milk production as the sum of three lactation yields. In Europe and North America generally, first five lactations are considered for lifetime productivity for selection of bulls and cows. Thus there is need to determine number of lactations to be included for prediction of lifetime performance. Various reports revealed that number of lactations completed (NLC) varied from 3.72±0.02 (Kuralkar and Raheja, 1997) to 6.30±0.11 (Dutt *et al.,* 2001) in Murrah buffaloes.

1.1Effect of period of calving

The significant effect of period of calving on NLC was reported by Kaushik *et al*. (1994) and Kuralkar and Raheja (1997).

1.2 Effect of season of calving

Kaushik *et al.* (1994) reported non-significant effect of season of calving on NLC. Kuralkar and Raheja (1997) reported significant effect of season of calving on NLC..

1.3 Effect of age at first calving

Thiruvenkadan *et al.* (2015) reported significant effect of AFC on number of lactations completed in Murrah buffaloes.

2. Lifetime milk yield (LTMY)

Buffaloes are not kept in herd until their natural death, Calculation of milk production for whole life is not possible in practice. Different criteria has been used for estimating lifetime milk production in dairy animals. Sharma *et al.* (1994) calculated lifetime milk yield as measured by yield upto five lactation in Murrah buffaloes. Sharma and Basu (1985) and Dutt and Taneja (1994) utilized the criteria of milk yield up to disposal or death for estimation of lifetime milk yield in murrah buffaloes. Kuralkar and Raheja (2000) defined lifetime milk yield as the total amount of milk produced by buffalo during the period she stayed in the same herd. Alli *et al.,* (2000) measured the lifetime milk yield up to 3 and 4 lactation in Murrah buffaloes. The lifetime milk yield reported in literature (Table 1) ranged from 5381.07±66.03 kg (Kumar *et al.,* 2015) to 10970±286 kg (Dutt *et al.,* 2001).

2.1 Effect of period of calving

Significant effect of period of calving on LTMY was reported by Dutt and Taneja (1994), Dutt *et al.* (2001) and Godara (2003) in Murrah buffaloes. While non-significant effect of period of calving on LTMY was reported by Dev (2015) in Murrah.

2.2 Effect of season of calving

Significant effect of season of calving on LTMY was reported by Tailor *et al.* (1998) in Surti buffaloes, whereas non-significant effect of season of calving on the same trait was reported by Dutt *et al.* (2001) Godara (2003) and Dev (2015) in Murrah buffaloes.

2.3 Effect of age at first calving

Significant effect of AFC on LTMY was reported by Thiruvenkadan *et al.* (2015). Non-significant effect of AFC on LTMY was reported by Godara (2003) and Dev (2015).

3. Productive life

The sum of number of days in milk in different lactations in the herd. The averages for number of days in milk ranged from 1017.20±35.88 days (Godara, 2003) to 1520.7±46.2 days (Thiruvenkadan *et al.,* 2015) in Murrah buffalo.

3.1 Effect of period of calving

Dutt and Taneja (1994) and Godara (2003) reported significant effect of period of calving on PL. While non-significant effect of period of calving on PL was reported by Dev (2015).

3.2 Effect of season of calving

Significant effect of season of calving on PL was reported by Godara (2003), however non-significant effect of season of calving on PL was reported by Dutt and Taneja (1994) and Dev (2015).

3.3 Effect of age at first calving

Thiruvenkadan *et al.* (2015) reported significant effect of AFC on PL in Murrah buffalo, while, non-significant effect of AFC on PL was reported by Godara (2003) and Dev (2015).

4. Milk yield per day of productive life

It is a production efficiency trait. It was measured as life time milk yield divided by the productive life. Different workers defined this production efficiency in different ways. Kalsi and Dhillon (1984) defined it as milk yield per day of total lactation period in Murrah buffaloes. Umrikar and Deshpande (1985) defined it as milk yield per day of productive life. Biradar *et al.* (1991) and Sharma *et al.*(1994) defined it as life time milk yield per day of lactation length in Murrah buffaloes. The average value of MY/PL ranged from 2.89±0.05 kg/day (Thiruvenkadan *et al.,* 2015) to 6.19±1.30 kg/day (Sharma *et al.,* 1994) in Murrah buffalo.

4.1 Effect of period of calving

Dutt and Taneja (1994) and Dev (2015) reported significant effect of period of calving on MY/PL.

4.2 Effect of season of calving

Reddy and Nagarcenkar (1988) and Dev (2015) reported non-significant effect of season of calving on MY/PL.

4.3 Effect of age at first calving

Non-significant effect of AFC on MY/PL was reported by Thiruvenkadan *et al.* (2015) and Dev (2015).

5. Herd life

Different workers defined herd life in different ways. Kalsi and Dhillon (1982) defined herd life as the age at last calving of the herd. Sharma and Basu (1986) defined herd life as the period between date of first calving and last calving. Kuralkar and Raheja (2000) defined herd life as the total number of days from first calving to date of death or disposal from the herd. The average herd life reported in the literature (Table 1) ranged from 2050.42±32.80 days (Chander, 2002) to 3951±54.30 days (Dutt *et al.,* 2001).

5.1 Effect of period of calving

Significant effect of period of calving on HL was reported by Dutt and Taneja (1994) and Dutt *et al.* (2001). While non significant effect on HL was obtained by Dev (2015).

5.2 Effect of season of calving

Non-significant effect of season of calving on HL was reported by Dutt and Taneja (1994), Dutt *et al.* (2001) and Dev (2015).

5.3 Effect of age at first calving

Significant effect of age at AFC on HL was reported by Thiruvenkadan *et al*. (2015). While non-significant effect of AFC on HL was reported by Dev (2015).

6. Milk yield per day of herd life

It was measured as lifetime milk yield divided by herd life. The value of MY/HL ranged from 1.41±0.04 kg/day (Thiruvenkadan *et al.,* 2015) to 4.77±0.04 kg/day (Kumar *et al*., 2015).

6.1 Effect of period of calving

Significant effect of period of calving on MY/HL was reported by Dutt *et al.* (2001). While non-significant effect of period of calving on MY/HL was reported by Dev (2015).

6.2 Effect of season of calving on milk yield per day of herd life

Non-significant effect of season of calving on MY/HL was reported by Dutt *et al.* (2001) and Dev (2015).

6.3 Effect of age at first calving on milk yield per day of herd life

Non-significant effect of AFC on MY/HL was reported by Thiruvenkadan *et al*. (2015) and Dev (2015).

(B) Heritability, genetic and phenotypic correlation among lifetime performance traits

(1) Heritability and Genetic and phenotypic correlations among lifetime traits

Heritability of a character is function of total variability that is attributable to genes and their effects. Heritability estimates of traits are useful for construction of selection indices, prediction of genetic response to selection and for deciding how much one can rely upon individuals own phenotype for selection. Hence, accurate estimates of different economic traits are indispensable in animal breeding programmes. Heritabilty estimates of various lifetime performance traits in Murrah buffaloes are summarised in Table 2. The heritability estimates of NLC ranged from 0.05±0.04 (Kuralkar and Raheja, 1997) to 0.26±0.16 (Dutt and Taneja, 1994), LTMY ranged from 0.09±0.05 (Bashir *et al.*, 2007) to 0.19±0.07 (Singh and Barwal, 2012) and the heritability estimates of PL ranged from 0.14±0.05 (Godara, 2003) to 0.26±0.17 (Dev, 2015).

Heritabilty estimates of MY/PL ranged from to 0.10±0.04 (Kuralkar and Raheja, 1997) to 0.17±0.02 (Chander, 2002), HL ranged from 0.01±0.06 (Bashir *et al.,* 2007) in Nilli-Ravi buffalo to 0.26±0.20 (Dev, 2015) and the heritability estimates of MY/HL ranged from 0.05±0.04 (Kuralkar and Raheja, 1997) to 0.20±0.24 Dev (2015). Kuralkar and Raheja (1997) observed that heritabilities for lifetime production traits is lower than heritability estimates of first lactation traits Low to moderate heritability estimates and larger generation interval encountered for lifetime performance traits do not hold much promise for enhancing lifetime performance through direct selection. But some emphasis should be given to longevity and lifetime milk yield in selection for dams of young bulls through indirect selection which would be based on earlier records. Furthermore, genetic and phenotypic correlation among lifetime performance traits have been reviewed in Table 2 revealed from moderate to high among lifetime performance traits indicated that selection based on any one of these traits could result into improvement through positive correlated response in all other traits.

CONCLUSION

The review of literature revealed that since selection on lifetime performance is not practically feasible due to long generation interval but lifetime performance traits should be included in selection criteria. The high to moderate heritability and correlations indicated that life-time milk yield, productive life and herd life was a better representative trait among all lifetime performance traits. These results also suggested that selection of relatives on the basis of lifetime milk yield, productive life and herd life would lead to positive genetic responses and high genetic gain.

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Table 1. Estimates of Least square means and heritability of lifetime performance traits of Murrah buffaloes

Traits	N	Means ± S.E	h2±S.E	References
NLC	1647	----------	0.17±0.07	Dutt and Taneja (1994)
	2107	3.72±0.02	0.05±0.04	Kuralkar and Raheja (1997)
	1164	6.30±0.11	--------	Dutt *et al.* (2001)
	755	3.00±0.08	----------	Thiruvenkadan *et al*. (2015)
LTMY (Kg)	2107	5588±40.20	0.17±0.05	Kuralkar and Raheja (1997)
	1164	10970±286.0	------	Dutt *et al.* (2001)
	230	6765.28±274.06	0.18±0.06	Godara (2003)
	1037	7722.9±163.7	0.09±0.05	Bashir *et al.* (2007)
	1213	5630.00±1383.88	0.19±0.07	Singh and Barwal (2012)
	1753	5381.07±66.63	----------	Kumar *et al.* (2015)
	553	5441.6±206.0	----------	Thiruvenkadan *et al.* (2015)
	171	8607.93±481.93	0.18±0.10	Dev (2015)
PL (days)	351	1261.79±24.48	0.21±0.11	Chander (2002)
	230	1017.20±35.88	0.14±0.05	Godara (2003)
	664	1520.7±46.2	--------	Thiruvenkadan *et al.* (2015)
	171	1161.59±54.17	0.26±0.17	Dev (2015)
MY/PL (kg/day) Up to 5th lactation	210	6.19±1.30	--------	Sharma *et al.* (1994)
	2107	----------	0.10±0.04	Kuralkar and Raheja (1997)
	351	5.76±0.04	0.21±0.11	Chander (2002)
	509	2.89±0.05	-----	Thiruvenkadan *et al.* (2015)
	171	5.59±0.15	0.11±0.04	Dev (2015)
HL (days) Up to disposal	1164	3951±54.30	------	Dutt *et al.* (2001)
	351	2050.42±32.08	0.09±0.04	Chander (2002)
	1037	------	0.01±0.06	Bashir *et al*. (2007)
	664	3078.4±46.30		Thiruvenkadan *et al.(*2015)
	171	3340.22±120.67	0.26±0.20	Dev (2015)
MY/HL (kg/day)	2107	2.58±0.02	0.05±0.04	Kuralkar and Raheja (1997)
	1164	2.60±0.04	------	Dutt *et al*. (2001)
	1753	4.77±0.04	-------	Kumar *et al.* (2015)
	509	1.41±0.04	-------	Thiruvenkadan *et al.* (2015)
	171	2.55±0.10	0.20±0.24	Dev (2015)

Table-2. Genetic and phenotypic correlations among lifetime performance traits

Correlation		References	Breed
Rg±s.e	**Rp±s.e**		
LTMY with PL			
0.91±0.46	0.94±0.06	Chander (2002)	Murrah
0.25±0.013	0.87	Bashir *et al*. (2007)	Nilli Ravi
0.88±0.08	0.90±0.08	Dev (2015)	Murrah
LTMY with NLC			
-0.56±0.39	-0.13	Kuralkar and Raheja (1997)	Murrah
----	0.926±0.019	Thiruvenkadan *et al*. (2015)	Murrah
LTMY with MY/PL			
0.87±0.11	0.55	Dutt and Taneja (1994)	Murrah
---	0.630±0.039	Thiruvenkadan *et al*.(2015)	Murrah
0.87±0.13	0.59±0.13	Dev (2015)	Murrah
LTMY with HL			
0.97±0.45	-0.71±0.04	Chander (2002)	Murrah
0.20±0.01	0.70	Bashir *et al*.(2007)	Nilli-Ravi
0.50±0.22	0.79±0.22	Dev (2015)	Murrah
and,			
LTMY with MY/HL			
0.25±0.23	0.10	Kuralkar and Raheja (1997)	Murrah
---	0.935±0.018	Thiruvenkadan *et al*.(2015).	Murrah
0.70±0.15	0.74±0.15	Dev (2015)	Murrah
PL with NLC			
0.97±0.03	0.94	Dutt and Taneja (1994)	Murrah
0.692±1.651	0.920±0.017	Thiruvenkadan *et al*.(2015)	Murrah
PL with MY/PL			
0.55±0.23	0.23	Dutt and Taneja (1994)	Murrah
-----	0.432±0.046	Thiruvenkadan *et al*.(2015)	Murrah
0.57± 0.24	0.42±0.24	Dev (2015)	Murrah
PL with HL			
0.25±0.23	0.10	Kuralkar and Raheja (1997)	Murrah
>1	0.77±0.01	Chander(2002)	Murrah
0.67±0.19	0.80±0.19	Dev (2015)	

PL with MY/HL

0.90±0.07	0.63	Kuralkar and Raheja (1997)	Murrah
------	0.851±0.027	Thiruvenkadan *et al.* (2015)	Murrah
0.49±0.24	0.20±0.24	Dev (2015)	Murrah

MY/PL with HL

0.97±0.68	0.68±0.01	Chander (2002)	Murrah
0.07±0.24	0.35±0.24	Dev (2015)	

MY/PL with MY/HL

0.19±2.502	0.781±0.031	Thiruvenkadan *et al*. (2015)	Murrah
0.83±0.09	0.56±0.09	Dev (2015)	Murrah

MY/PL with NLC

-----	0.539±0.043	Thiruvenkadan *et al* (2015)	Murrah

HL with MY/HL

-0.58±0.26	-0.10	Kuralkar and Raheja (1997)	Murrah
0.20±0.24	0.25±0.24	Dev (2015)	Murrah

Millets: The miracle grains

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Millets are an often overlooked staple food for millions living in the harshest, food-insecure regions of the developing world. They are rich in micronutrients - far more so than most rice, maize and wheat varieties. They are extremely resilient in the face of drought and other abiotic stresses, making them valuable food security crops for millions living in marginal environments. Millets need very little water for their production. Compared to irrigated commodity crops, currently promoted by policy measures, millets need no irrigation and require just around 25% of the rainfall regime demanded by crops such as sugarcane and banana. Thus, they do not burden the state with demands for irrigation or power. Millets are adapted to a wide range of ecological conditions often growing on skeletal soils that are less than 15 cm deep. It does not demand rich soils for their survival and growth. Hence, for the vast dry-land area, they are a boon. Millet production is not dependent on the use of synthetic fertilizers. Most millet farmers therefore use farmyard manures and in recent times, household produced bio-fertilisers. Therefore, they can significantly reduce the huge burden of fertilizer subsidy borne by the government. Grown under traditional methods, no millet attracts any pest. They can be termed as crops. A majority of them are not affected by storage pests either. Therefore, their need for pesticides is close to nil. Thus, they are a great boon to the agricultural environment. Millets are amazing in their nutrition content. Each of the millets is three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals and vitamins.

Millets as Climate Change Compliant Crops

All these above qualities of millet farming system make them the climate change compliant crops. Climate change portends less rain, more heat, reduced water availability and increased malnutrition. If there is any cropping system that can withstand these challenges, survive and flourish, it is the millet system. It is important to note that with the projected 2 degree Celsius temperature rise, wheat might disappear from our midst, since it is an extremely thermal sensitive crop. Similarly, the way rice is grown under standing water makes it a dangerous crop under climate change conditions. Methane emanating from water-drenched rice fields is a green house gas, which severely threatens our environment.

Millets are all-season crops cultivated round the year whereas wheat is season

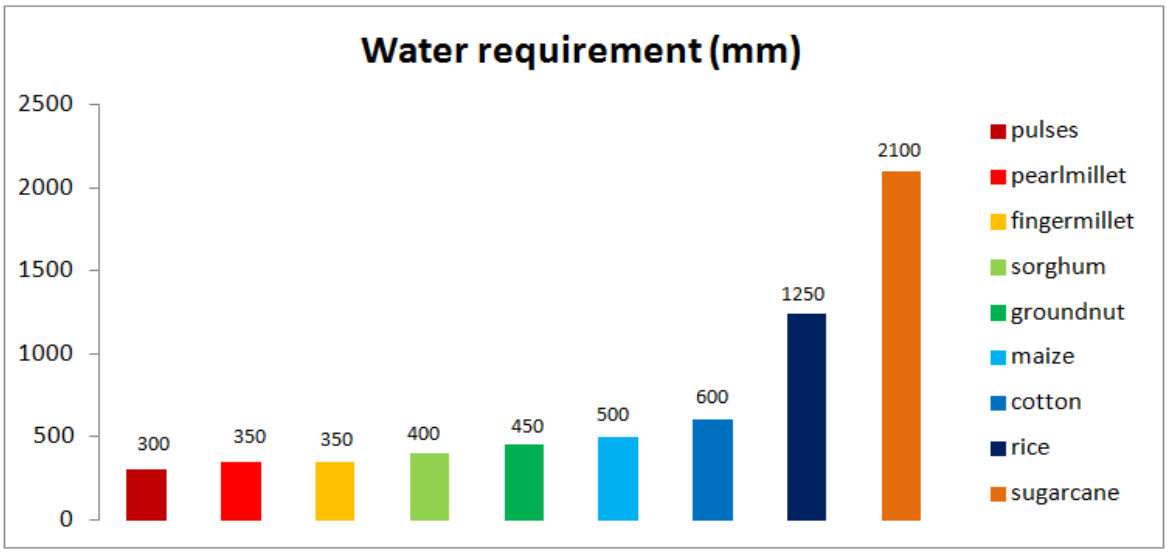

Figure 1: Comparison of Water requirements of Different crops (in mm) (Sharma, 2007)

specific. While wheat and rice might provide only food security, millets produce multiple securities (food, fodder, health, nutrition, livelihood and ecological) making them the crops of agricultural security.

Profile of millets: the foods of Future

Millets are astonishingly low water consuming crops. The rainfall needed for Sorghum, Pearl Millet and Finger Millet is less than 25% of sugarcane and banana and 30% that of rice. We use 4000 litres of water to grow one kg of rice while all millets grow without irrigation. This can turn out to be a tremendous national gain especially in the ensuing decades of climate crisis (Sharma, 2007). In a future, where water and food crisis stares us in the face, millets can become the food of security.

Millets are store-houses of nutrition

By any nutritional parameter, millets are miles ahead of rice and wheat. Each one of the millets has more fibre than rice and wheat. Some of them have as much as fifty times fibre than that of rice. Finger millet has thirty times more Calcium than rice while every other millet has at least twice the amount of Calcium compared to rice. In their Iron content, foxtail and little millet are so rich that rice is nowhere in the race. While most of us seek a micronutrient such as Beta Carotene in pharmaceutical pills and capsules, millets offer it in abundant quantities. The much privileged rice, ironically, has zero quantity of this precious micronutrient. In this fashion, nutrient to nutrient, every single millet is extraordinarily superior to rice and wheat and therefore is the solution for the malnutrition that affects a vast majority of the Indian population.

Millets are pest free crops

Growing traditional local landraces and under ecological conditions, most millets such as foxtail are totally pest free and hence do not need any pesticides. Even in storage conditions, most millet such as foxtail not only not need any fumigants, but act as anti pest agents to store delicate pulses such as green gram.

Figure 2 Great Millet/Sorghum

Figure 3 Spiked Millet/Pearl Millet

Figure 4 Finger Millet

Figure 5 Italian Millet/Foxtail Millet

Figure 6 Little Millet

Figure 7 Kodo Millet

Figure 8 Common Millet/Proso Millet

Figure 9 Barnyard Millet

Table 1: Nutrient Content of Millets

Crop / Nutrient	Protein(g)	Fibre(g)	Minerals(g)	Iron(mg)	Calcium(mg)
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14
Kodo millet	8.3	9	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Barnyard millet	11.2	10.1	4.4	15.2	11

Millets grow on the poorest of soils

Most millet can be grown on low fertility soils. Some can grow in acidic while others in saline soils. Millets such as Pearl millet can also be grown on sandy soils, as is done in Rajasthan. In fact, finger millet grows well in saline soils. Barnyard millet too thrives in problem soils, where other crops like rice, struggle to grow in such soils. Many of them are also grown to reclaim soils. Poor farmers especially in dry-land India are owners of very poor lands. Much of the cultivable fallows and low fertility farms have been handed to them through the process of land reforms and the Jajamani system of Inam lands. The only crops that sustain agriculture and food security on these lands are millets. In fact, the capacity of millets to grow on poor soils can be gauged from the fact that they grow in Sahelian soil conditions in West Africa which produces 74% of all the millets grown in Africa and 28% of the world production. If they flourish in such ecological zones where average rainfall can be less than 500 mm using soils that are sandy and slightly acid, it is a testimony for their, hardiness and extraordinary capacity to survive very harsh conditions. That is why millets can withstand drought like conditions in the Deccan and Rajasthan and produce food and fodder for people and livestock, respectively.

Millets do not demand synthetic fertilisers

Millets do not demand chemical fertilizers. In fact, under dry land conditions, millets grow better in the absence of chemical fertilizers. Therefore, most millet farmers grow them using farmyard manure under purely eco-friendly conditions. In recent years farmers have also started using bio-fertilisers such as vermin-compost produced in their backyard and growth promoters such as panchagavya, amrit pani etc. These practices make millet production not only eco-friendly but stays under the control of farmers.

Millets are not just crops but a cropping system

Most millets grown under traditional practices are a Farming System and not just a crop. Most millet fields are

inherently biodiverse. This is the tradition of millet farming in the country. Six to twenty crops are planted on the same space at the same time. The famous Baranaja cropping systems in the Himalayas are a testimony to this. In this millet led system are embedded 12 different crop varieties. Saat Dhan in Rajasthan also is a host to a large variety of millets. The Pannendu Pantalu system of the South, grow millets in combination with pulses and oilseeds, thus making it a holistic farming system.

Millets produce multiple securities

While single crops such as rice and wheat can succeed in producing food security for India millets produce multiple securities. They include securities of food, nutrition, fodder, fibre, health, livelihood and ecology. Most millet has edible stalks which are the most favoured fodder for cattle. Many a time, crops such as sorghum and pearl millet are grown only for their fodder value. Besides fodder, millets are storehouses of nutrition and hence produce nutrition security. Being hosts to diverse crops such as red gram, millet fields also produce fuelwood and fibre through amaranth. The legume crops that are companion crops for millets are also prolific leaf shedders. This leaf fall acts as natural manure and maintains soil fertility. Thus, millet farms not just use soil fertility for their growth but also return this fertility to the soil.

Millets are climate change compliant crops

Due to all the qualities mentioned above, Millets remain our agricultural answer to the climate crisis that the world is facing (CSE, 2007). Climate Change is expected to confront us with three challenges.

- Increase in temperature upto 2-5 degree Celsius
- Increasing water stress
- Severe malnutrition

Only millets have the capacity to meet this challenge

Since they are already capable of growing under drought conditions, they can withstand higher heat regimes. Millets grow under non-irrigated conditions in such low rainfall regimes as between 200mmand 500 mm. Thus, they can also face the water stress and grow. This makes them “climate smart”, and a good source for genetic traits that can strengthen the resilience of other crops in the face of climate change. As climates get hotter and drier, small millets and the more dominant dryland cereals will become increasingly well suited for production in areas where other crops are now grown. Each of the millets is a storehouse of dozens of nutrients in large quantities. They include major and micro nutrients needed by the human body. Hence they can help people withstand malnutrition. Small millets consist of a about a dozen distinct species of small-seeded grasses that are grown for grain, each with their own unique traits and value. The most economically significant of these at present is finger millet, but the other small millets are each in their own way important to the farmers who grow them. They are also potentially important to breeders of other cereals as sources of traits that can improve the resilience and nutritional value of those more widely grown crops.

Millets in general provide many essential vitamins and micronutrients that can bolster nutrition for those living

in dryland areas, particularly women and children. Small millets are especially rich in iron, zinc and calcium, and have other dietary qualities that can help stave off anemia, celiac disease, and diabetes. This high nutritional value – coupled with the impressive hardiness of small millets – makes them desirable food security crops, as well as a good sources of fodder and feed in mixed crop/livestock systems. In view of all these features that they so amazingly combine, millets can only be called as Miracle Grains.

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Chlamydiosis In Sheep and Parrot:

An Important Zoonotic Threat

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Chlamydiosis (gestational psittacosis) Chlamydophilae are intracellular parasites and have biphasic reproductive cycle, in which only one phase is infective. Previously, it was not possible to determine if the *Chlamydophila* spp. responsible for infection in birds was the same as that seen in sheep and other species, because the serological and PCR tests used for diagnosis were not sensitive enough to produce species differentiation. Recently, the species have been differentiated and reclassified and it is now known that the species of *Chlamydophila* responsible for infection in sheep and goats is a separate species, *C. pecorum* and has been found in cattle, goats, sheep, swine and koalas, although it is not implicated in causing abortion. The species found specifically associated with cases of abortion in cattle, sheep and occasionally humans is identified as *C. abortus*. In addition to the main species mentioned above, there is another species of *Chlamydophila*, *C. felis* (feline keratoconjunctivitis agent), which typically causes rhinitis, pneumonia or conjunctivitis in cats. This strain can also be transmitted to humans, but it is extremely rare. The resulting conjunctivitis responds to the use of antibiotic eyedrops or eye ointment, particularly chlortetracycline or fusidic acid.

Disease in animals

The species found in sheep, goats and occasionally cattle can cause a chronic infection, particularly in female animals. The disease in sheep is known as enzootic abortion and in flocks with high incidence of infection is a major cause of economic losses due to low numbers of live-birthed lambs. It is usually isolated from the uterus and other reproductive organs. In pregnant animals it causes placental insufficiency and abortion. The infection appears to be transmitted between animals by either the sexual or the faecal–oral route. Infected animals pass live organisms in the faeces and after abortion or birth the organism is found in the uterus, vagina and placental material.

Lambs may also be contaminated, especially before maternal cleaning has occurred.

Transmission

Transmission to humans occurs by inhalation of dried faecal matter, direct contact with faeces or contact with pregnant or postpartum ewes, lambs, birth fluids or placental tissue. The organism is capable of surviving desiccation and survives in dung or soil for several months.

Disease in humans

Incubation period in humans varies from 1 to 4 weeks. The disease usually then presents as an influenza-like illness with cough and congestion followed by high fever, aching muscles and occasional back and abdominal pain. Respiratory symptoms are common, with dry cough and pneumonia. Anaemia and liver dysfunction with hepatic and splenic enlargement may also be present. In pregnant women the disease may be life threatening. The disease can progress to give placental insufficiency, neonatal distress, and late term miscarriage or premature birth. In some cases, emergency termination may be necessary to save the mother's life. Disseminated clotting may occur in all major blood vessels.

Diagnosis

Diagnosis is usually made using immunofluorescence techniques, ELISA or PCR tests.

Treatment

Tetracyclines or erythromycin is the drug of choice. Erythromycin is preferable in pregnant women because tetracyclines are contraindicated in pregnancy, although in resistant cases they may need to be used where the benefits of treatment outweigh the risks. Caesarean section at early term may also be necessary.

Prevention

Sheep may be vaccinated to reduce the incidence of enzootic abortion and shedding of organisms. During handling of pregnant ewes suitable protective clothing should be worn, including face protection,. Ewes that have aborted should be isolated until any vaginal discharge ceases. Pregnant women should, wherever possible, avoid contact with pre-, peri- or postpartum ewes or goats, and kids or lambs. Contact with placental material or aborted lambs must be avoided. They should not handle unwashed overalls that may be contaminated with blood or secretions from ewes or lambs or milk ewes. Any pregnant woman who has been in contact with sheep should seek medical advice if she has an onset of influenza-like symptoms or fever.

Psittacosis (ornithosis)

Psittacosis is known as 'parrot's disease'. The disease is also referred to as avian chlamydiosis (AC). The causative agent is *Chlamydophila psittaci* which typically, like all other *Chlamydophila* spp., is an intracellular parasite. It has also biphasic reproductive cycle, with only one phase being infectious. This is closely related to *Chlymadia* organism of sheep, although the pattern of disease and the transmission pathway are very different.

Disease in animals

C. psittaci is widespread in both wild and domestic birds. Parrots are the most frequently encountered hosts in a

companion animal setting and 1% of the population are estimated to have active disease at any time. Other potential hosts as zoonotic reservoirs include turkeys, ducks, geese, pigeons, starlings, pheasants and birds kept for competitive showing. These range from 50% to 100% of all feral pigeons within a population sample. The number of birds infected within a population increases where overcrowding or stress occurs. The associated levels of inadequate ventilation and cleanliness in poor and overcrowded commercial housing also promote the rate of infection with the disease in commercial flocks. Infection in birds is usually subclinical and may remain latent for a period of months or years. Apparently healthy birds can shed viable organisms and cause infection in others during the latent period. The pathogen can survive in the environment for extended periods following contamination with infected droppings or aerosols originating from the nasal discharge of infected birds. The organism is resistant to drying and can be found in dust in hen houses, pigeon lofts and other roosting sites. Bird cages, pet shops, lofts or roof spaces inhabited by wild and feral species must be treated as possibly contaminated.

Transmission

Transmission to humans follows inhalation of dried bird faeces or nasal discharge from infected birds, direct contact with birds or their feathers and by bird bite (a rare but possible occurrence, especially in aggressive non-domesticated parrots). Once across the species barrier, human-to-human transmission may occur by the aerosol route. Poultry workers in the turkey industry, in either rearing or processing birds, show an increased incidence of the disease. Individuals who handle wild, pet or domesticated birds in any setting are at increased risk. Verification of the presence of *C. psittaci* may be difficult; as yet there is no rapid test available to differentiate serologically between this and other *Chlamydophila* spp.

Disease in humans

The infection may be subclinical, leading to under-diagnosis. Onset of the disease is gradual; an incubation period of 1–4 weeks is followed by a series of symptoms similar to influenza or a respiratory infection. Symptoms include malaise, fever, chills and headache, and associated photophobia and nonproductive cough. An unusual feature is that, although the temperature is elevated, the pulse rate does not undergo an associated rise. Joint and muscle pain with weight loss and loss of appetite may also be seen. Occasionally a full-blown acute pneumonia may occur. Rarely seen in children, the infection is most severe in elderly and immunocompromised individuals. In severe cases, liver and splenic enlargement with gastrointestinal symptoms, including vomiting, diarrhoea and constipation may occur. Cardiac involvement with valve failure and endocarditis is also
possible. Spread into the CNS may follow with disorientation, depression or delirium followed by meningitis or encephalitis. Severe breathing difficulties can follow exacerbation of pulmonary symptoms. Death can follow pulmonary insufficiency and toxaemia. In clinical cases fatality occurs in
approximately 1%.

Treatment

Treatment consists of tetracyclines as the antibiotic of choice, with supportive measures. Tetracycline is given at a dose of 250–500 mg three to four times daily for at least 7 days, with the treatment period extended as needed. Doxycycline has also been used at a dose of 200 mg/day, as has azithromycin and erythromycin, although their use is normally associated with *Chlamydophila* spp. which cause urinogenital infection or endocarditis. Early diagnosis is very important to reduce complications and prolonged treatment may be required to prevent reinfection or relapse in some cases. It is recommended as good practice to inform a consultant in communicable diseases of cases of psittacosis where there could be a public health risk.

Prevention

Prevention depends on education of individuals in high-risk groups. Early detection of cases in birds is an important part of any prevention strategy. Reduction in stress and overcrowding is recommended to control infective spread. Placing birds suspected of having psittacosis in isolation until they can be tested, and subsequently treated or slaughtered in confirmed cases, is also recommended as good working practice. Treatment of imported companion birds with prophylactic antibiotics is important, especially before their sale as pets. Good flock management at agricultural sites can reduce infection, and feral birds should be excluded from feed mills and rearing sheds. No vaccines are available for either humans or birds.

Nature of agricultural loan defaults in India

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Agricultural sector plays major role in the Indian economy by contributing 13.9% of India's total GDP. It is the most important source of livelihood and nutritional security for nearly about 70% of the Indian population. Many industries have to directly or indirectly depend on it for the raw materials (Singh A.P and Singh P.K., 2016). According to National Commission on Agriculture (1976), faster growth of agricultural sector needed not only its own sake but also for the sake of economics of whole country because prosperity of country depends upon only on it. If agriculture not progress, there will break to industrial expansion results in stagnates of real growth. It is well known that we cannot increase the area of cultivation. So, it is better to boost agriculture by concentrating on intensive cultivation. During early sixties, new technology leads to green revolution. It make lot impact on farmers because High Yield Variety (HYV) of seeds, pesticides, fertilizers, irrigation, machinery and equipments etc. require higher capital which is beyond the scope of farmers. Due to capital intensive nature of these input technologies, farmers have to depend upon borrowing. Due to transfer of traditional or substantial farming system to commercial farming, there was increase demand of credit (Mathur B.S., 1974). Actually, the rural credit structure classified as the institutional and non-institutional credit lending agencies. In the structure of non-institutional credit delivery system, there are moneylenders, traders, commission agents, agro-shop dealers, friends, relatives. The development of institutional credit was only primary condition for agriculture development. Credit requirement of farmers are classified on the basis of period, as short-term, medium-term and long-term loan. Short term loans provided for seasonal agriculture operations to raise crops and also include reliable amount of maintenance needs of farmer and his family, given for period of 9 to 12 months. Medium-term loans are given for the purpose of cattle and farm implements for the duration of 12 month to 5 years. Long term loans are given for the period of 12 month to 5 years to improve land permanently, digging and repairing of well, motors purchase, farm house construction and for plantation.

When we see the history of advanced countries, integrated system of institutional credit make symbol of agriculture wealth. It is important to note that institutional agriculture credit has enhanced on overall basis but there is wide inequality in growth of each regions of the country. Further, it is well known that there is high dependency of the small and marginal farmers on non-institutional sources. There are many reasons like high transaction cost in the formal institutions due to complex lending procedure, high documentations and tangible loan collaterals whereas availability of flexible lending, no loan documentations and loan security in non-formal institutions. Even increased transaction cost in Institutional credit system is also due to heavy overheads and more number of small loans. The idea behind institutional credit not to stimulate only agriculture productivity, it is also to make enhancement in vicious circle of poverty and debt. Indebtedness and poverty are closely related phenomenon for Indian farmer. According to Darling, ''The Indian peasant is born in debt, lives in debt and dies in debt''. In current time, there is increase in suicides of farmers in many parts of India due to increase in indebtedness in rural area that is due to decrease in agricultural production, productivity and incomes. Indebtedness has known to be one of the main obstructive stone on the way of rural property. It has cancerous property. It stumble agriculture production, embarrass social psyche, aggravates inequality in allocation of socioeconomic opportunities and benefits, stops social progress and misdirect social efforts. It is extremely difficult to cure indebtedness within institutional structure of Indian society. It is there because problems of poverty, unequal distribution of economic resources, type of indebtedness, that all helps to unify causes of poverty and distributional injustice. This vicious cycle can break surely but it requires strong will and determined efforts. Initially the weaker link should identify and appropriate strategies should adopted because, rural Indebtedness is not only specifically sociological, economic or political problem but it is serious and crucial problem which has roots in social, economic and political texture of the society. The problem of Indebtedness should critically examine and appropriate measures must be implemented. It is important for agricultural credit institutions to study growth and distributional aspects of credit over the time, its role to enhance use of modern production inputs and formation of capital from private sources and also scrutinise advantage and disadvantages to meet objective of equity, cost effectiveness, low and adequate prices of agricultural products while implementing agriculture credit policy. It is also needed to expand institutional structures, lending to disadvantaged people and low interest rates (Joseph J.P., 2010).

Causes of Rural Indebtedness

There are several factors regarded as cause of Indebtedness in rural systems. Especially socio-economic structure of rural system is responsible for more borrowing nature of the farmers. They borrow to satisfy their needs but their earning from agricultural is very less. Borrowing is common phenomenon in the world but the fact about Indian farmer is totally differ that they face many

economic problems in day to day life hence they many time unable to return that amount of debt. The amount of debt is multiplying years after years.

1. **Chronic poverty of farmers:**

Need of borrowing always arise for the purpose of production or consumption due poverty. Poverty is there because of Indebt. It is vicious cycle in which poor farmers has been trap. It has not yet been removed from Indian rural systems since many years of freedom. Small and middle peasants could not live if they could not get extra wages. Small farmers have to goes in vicious cycle by increased interest rate, poverty and indebtedness. People could not save earnings due to poverty. It becomes mandatory for them to borrow due to adverse circumstances in family, monsoon failure or foods and other calamities. It becomes hard when small farmers have to sell their land to fill loans and become chronically poor. It is argued that increase in value of agriculture products has lead to increase some income from farming but, one have to consider the latest available technology which is highly cost intensive in nature.

2. Ancestral debts:

It is major cause of indebtedness among the farmers according to the Deccan Riot Commission. Debt being passed from father to his son and generation after generation, acts without any restrictions. As inherited debt come on head from their forefathers and due to poverty, they unable to pay the loan, they borrow money from private money lenders. As they repay loan, there is higher interest amount of money waiting for them which given by lenders. One must have to remember that heirs have not legally obligation to repay the present debts taken by their ancestors unless and until the heirs succeeds to deceased debtor's property. So, there is ignorance of law that compels farmers to repay debts of their forefathers. In most of the conditions, heirs see the debt as their duty to discharge due to religious obligations or personal understandings.

3. Excessive pressure of population on land:

Due to increasing population day by day, there is increasing pressure on the land as pet capita income is going to decline. The land available for farmers is not sufficient for the enough production result in increased borrowing rate. The average land holding in India is very less. Further, In all the states, the land is dividing in sub divisions by the law of inheritance and succession. Due to small farm scattered over different place, there is reduction in agricultural productivity and per capita production.

4. Unfavourable climatic conditions:

Indian agriculture is gamble of rains. Failure of rains frequently results in droughts. Excessive rain is also responsible for damage of crops. Other than that, hailstorms, raids of locusts and fire also damage the crops severely.

5. Heavy cattle mortality:

Farmers are unable to maintain their material capital as cattle. Floods and drought condition result in loss of this material capital. Sudden epidemic diseases are make farmer helpless. Loss of cattle results in borrowing because small farmers cannot cultivate their land without draught animals.

6. Illiteracy of farmers:

Illiteracy and ignorance of farmers are major obstructing stone in overall improvement of the cultivators. They are

not desired in long term improvement in land for production. They are not interested in understand of term and conditions of loans. They easily ignore laws of land. This people easily cheated by private money lenders who provide credit. Due to illiteracy, the farmers are unable to do proper documentation. There is increased compound interest because farmers have not understood consequences of loan. Sometimes interest amount may exceed principle amount. Mostly private money lenders grab poor illiterate farmers in complex loan repayment conditions.

7. Extravagance of the farmers:

Farmers afford more money on social and religious ceremonies such as marriages, festivals, funerals, shraddh and kalhas, caste dinners, social feasts etc. They are unable to understand repayment capacity. They even not think to repay although they reap good harvests.

8. Litigation:

Higher interest on Litigation is also major reason to higher indebtedness among farmers. These majorly affect to illiterate farmers. Long durations of law battle result in loss of time, energy and money.

9. Poor and ill health of the farmers:

Poor and ill health are results in miserable condition to the farmers. Mostly farmers do not maintain health properly. There is not proper availability of health services also in many rural areas. Under nutrition is general complaint. The malnutrition conditions results in easy endemic and other diseases outbreak. When they become ill, they do not have enough saving for treatment. They have to borrow money at very higher interest rate. Improper health badly affects productivity and their income.

10. High interest rate:

Private money lenders in rural area always lend money in higher interest. The repayment methods are complex and arouse indebtedness easily.

11. Moneylender only source of borrowing:

Private money lenders are only source of provision of credit to farmers in rural areas. Due to absence of formal institutes, Moneylenders severely impose monopoly on small farmers. These lenders also increase actual amount of loan in records when small farmers are illiterates. They initially provide loan easily and then torture regularly make them to commit suicides also.

12. Burden of land revenue and other taxes:

Heavy land, irrigation tax and some indirect taxes are also responsible for indebtedness to the farmers. Many times, it may happen that small farmers are unable to pay revenue because they could not satisfy their own needs also.

13. Low holding capacity of farmers:

Farmers cannot hold crops for more time for appropriate price. Usually they sell their produce within harvesting season many times. Lack of facilities for the storage, absence of appropriate market arrangements, land revenue demands and pressure of payment of interest etc. are major reason to sell produce in cheaper rates.

Effects of Indebtedness

Indebtedness directly affects economic, social and political life of Indian farmers. It degrades their morale and leaves them to fatalistic situations, snatch their productive efficiency and drag them to

vicious circle of poverty. It is so tied hard that it is difficult to escape from that. Many times he has to give whole his final produce to moneylenders to fill loan. Sometimes indebtedness leads to tense atmosphere in villages that leads to further violence, class struggle and mutual jealousy that further decrease agricultural production. Farmers produce only for subsistence living and he sows because his creditor may gain. The worst situations become thereafter, the cultivator become landless labour whereas money lenders become absentee landlords.

1. **Economic Effects:**

- Although the cultivators losing productive efficiency, they not think about permanent improvement of loans. They feel that these efforts may leads to no benefits. But, at the last, the more production is not seen there.
- When non cultivator become cultivator (absentee landlords), they do not know how much labours needed because their non-agricultural background.
- It is fact that farmers have to sell their produces on lower price which is decided by moneylenders. Seeds and other inputs should buy as decided by moneylenders.
- Duration of crop holding depend upon moneylenders.
- Farmers have to leave their property which he has more love and affections.

2. **Social and Moral Effects:**

- Mostly landless peoples have to depend on landlords who mostly pressured on them. The economic situation of these landless labours so worsen that they have to depend only on these landlords. This condition is not good for Indian social context because majority of populations from this peasants only.
- Small holder farmer become marginal farmer and marginal farmer become landless labour. There is sharply degrading standard of living of these peasant.
- Indebtedness causes frustrations to cultivators that they lifelong worry about that and they cannot able to relieve themselves. Mental frustration results in moral degradation. It results in fatality.
- Incentives of hard working, risk taking ability, permanent improvements and increase in income is totally gone as whole outlook changed. This situation make great problem to the growth o rural area.

3. **Political Effects:**

- Indebtedness greatly influences political status of small and marginal farmers. Big landlords make great pressure on peasants to give vote according to their interest. The condition results in great loss on freedom to vote to desired leader.
- Landlords/Moneylenders use debtors in dirty practices and crimes many a time that poisons the political atmosphere results in further social tension.

Incidence and nature of Indebtedness

Based on the Situation Assessment Survey (SAS) report of Agricultural Households conducted in the 70th round of National Sampling survey (NSS) during January 2013 to December 2013, about 52% of the agricultural households in the India were estimated to be indebted.

Average amount of loan per household was estimated to approximately □47000 (Table1). When average amount of loan per agricultural household provided with size class of land possessed by each households, the percentage of indebted households range from 41.9 to 78.7% at all India level. Average amount of loan was increased as size of class of land possessed except farm land size <0.01. But, as size of land increase there was increase in indebtedness of agricultural households (Fig. 1)(NSSO 2013).

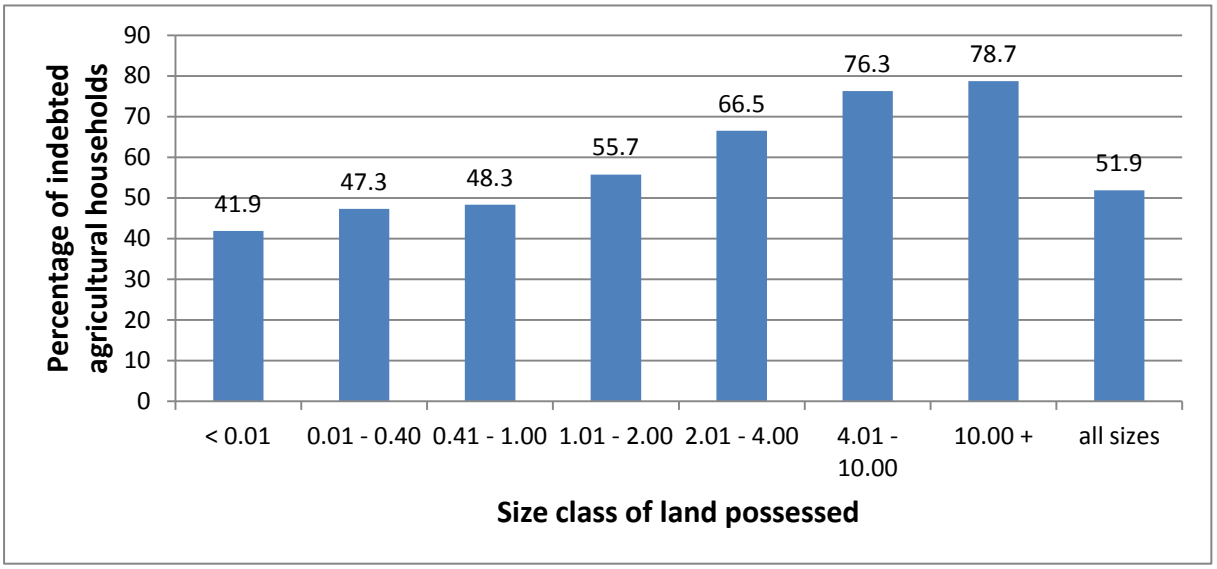

Figure 1. Percentage of indebted agricultural households for each size class of land possessed (ha.)

When all the states of India considered, Andhra Pradesh shares first position in percentage of indebted agricultural households (92.9%). Then after, Telangana (89.1%) and Tamil Nadu (82.5%) come. Assam (17.5%), Jharkhand (28.9%) and Chhattisgarh (37.2%) were major States with the lower share of indebted agricultural households (Table 2). At the time of survey, average amount of loan was highest for Kerala followed by Andhra Pradesh and Punjab. Assam followed by Jharkhand and Chhattisgarh had lowest amount of average outstanding loan. In Indian context, agricultural household having more land size (say, having 2.01 ha. or more land) had higher average loan compared to that of lower land size in all major states except few cases. Indebtedness regarding agricultural households having lower size land (less than 0.01 ha. and also landless labourers) had more significance due to their lower income level and high dependency on wage/salary employment from agricultural activity. Andhra Pradesh followed by Rajasthan and Kerala contained these agricultural households having largest amount of loan share.

Average agricultural household normally depend more on institutional sector (59%) as compared to non-institutional sector. In Institutional sector, Banks plays major role having 42.9 % of total loan provided (Table 3).

Agriculture household less than 0.01 ha. of land normally depend upon non-institutional sector for loan purpose. As size class of land holding increased, agricultural household rely more upon

institutional sector especially on banks (Table 3).

Table 4 denoting distribution of outstanding loan according to interest rates. Average interest rate from institutional source was 11.67% whereas 25.20% for non-institutional sources. On an average, agricultural household obtained loan on 17% of interest.

On an average, agricultural household obtained loan for nearly 2.16 years but, more share was on short term loan, less than one year.

Outstanding loan obtained for different purpose by agricultural households like farm business, non-farm business, medical, education and for other expenditures. The Other expenditures shares more (51%) followed by agricultural farm business (29%) (Satyasai, K.J.S. (2015).

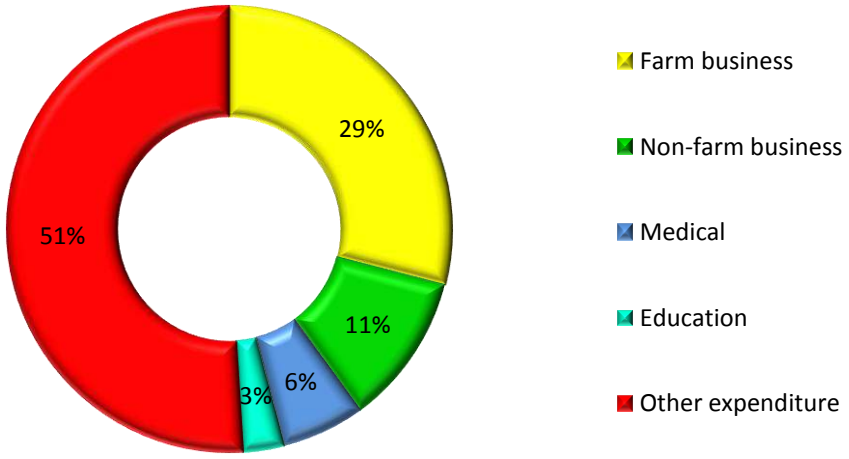

Figure 2. Loan outstanding according to purpose

Conclusion:

Indebtedness and poverty are major interrelated problems to Indian Farmers. Due to increase in vicious circle of poverty and debt day by day, there is increase in no. of suicides by farmers. Many of them have to depend on non-institutional sources of loan. Capital intensity of input technology in agriculture has again makes the things more complex. To overcome the present agrarian crisis, it is necessary for government institutions to make easily availability of loan to landless, small and marginal farmers. It is suggested to correlate scientific training in agricultural sector with provision of loan for the benefit of these vulnerable peoples.

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Table 1. Percentage of indebted agricultural households and average amount (□ 00) of outstanding loans per agricultural household for each size class of land possessed

size class of land possessed	average amount (□ 00) of outstanding loan per agricultural household	percentage of indebted agricultural households	estimated number of agricultural households
< 0.01	311	41.9	23890
0.01 - 0.40	239	47.3	287663
0.41 - 1.00	354	48.3	314811
1.01 - 2.00	548	55.7	154577
2.01 - 4.00	949	66.5	84345
4.01 - 10.00	1827	76.3	33019
10.00 +	2903	78.7	3706
all sizes	**470**	**51.9**	**902011**

Table 2. Average amount (□ 00) of outstanding loan per agricultural household by size classes of land possessed for major States

State	Average amount (□ 00) of outstanding loan per agricultural household by size class of land possessed								Percentage of indebted agricultural households
	<0.01	0.01-0.40	0.41-1.00	1.01-2.00	2.01-4.00	4.01-10.00	10.00 +	All sizes	
Andhra Pradesh	2409	739	893	1049	1623	3500	2494	1234	**92.9**
Assam	4	8	24	67	71	173	0	34	**17.5**
Bihar	73	138	132	341	279	424	1494	163	**42.5**
Chhattisgarh	0	48	93	79	202	239	0	102	**37.2**
Gujarat	69	120	247	311	826	1624	1148	381	**42.6**
Haryana	95	192	737	900	1573	1162	4681	790	**42.3**

Jharkhand	0	56	46	85	92	200	0	57	**28.9**
Karnataka	355	778	633	987	1248	2321	3673	972	**77.3**
Kerala	1690	1592	1944	3467	6070	7505	15726	2136	**77.7**
Madhya Pradesh	91	119	152	270	629	1168	1952	321	**45.7**
Maharashtra	102	453	232	455	582	2071	3869	547	**57.3**
Orissa	88	167	337	181	326	1302	22281	282	**57.5**
Punjab	131	246	516	1641	2292	3266	9274	1195	**53.2**
Rajasthan	1694	334	431	678	1031	1548	1528	705	**61.8**
Tamil Nadu	377	674	1192	1200	2147	3224	4512	1159	**82.5**
Telangana	563	578	794	1033	1097	1369	2690	935	**89.1**
Uttar Pradesh	219	160	218	457	1075	1248	2178	273	**43.8**
West Bengal	57	146	197	330	329	435	2760	178	**51.5**
All-India	311	239	354	548	949	1827	2903	470	**51.9**

Table 3. Distribution of outstanding loans (in %) by source of loan taken for different size classes of land possessed

Credit agency	**<0.01**	**0.01-0.40**	**0.41-1.00**	**1.01-2.00**	**2.01-4.00**	**4.01-10.00**	**10.00 +**	**All size**
Instiutional	**14.9**	**46.9**	**53.2**	**64.8**	**67.5**	**71.5**	**78.9**	**59.8**
government	0.4	1.3	1.7	2.6	1.9	3.8	1.1	2.1
Coop Society	1.6	14.6	13.9	14.7	15.6	17.5	14.3	14.8
bank	12.9	31.0	37.6	47.5	50	50.2	63.5	42.9
Non-institutional	**85.0**	**53.0**	**46.8**	**35.1**	**32.5**	**28.5**	**21.0**	**40.2**
agricultural/ professional money lender	63.7	32.4	27.4	23.3	23.8	18.7	16.1	25.8
landlord/employer	0.6	0.8	0.8	0.7	1.4	0.4	0	0.8
shopkeeper/trader	1.4	2.5	6.6	1.5	1.2	1.4	0.5	2.9
relatives/friends	17.5	14.2	10.6	7.6	5.8	6.5	3.8	9.1
others	1.8	3.1	1.4	2.0	0.3	1.5	0.6	1.6
All	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 4. Distribution of loans outstanding according to interest rate

Interest rate class	% distribution of outstanding debt		
	Institutional	Non-institutional	all
nil	0.8	18.3	8.5
<6	7.1	2.3	5
6-10	26	0.4	14.7
10-12	12.9	0.7	7.5
12-15	42.6	4.1	25.7
15-20	7.3	5.6	6.6
20-25	2.1	33.9	16.1
25-30	0.1	0.6	0.3
>30	1	34.1	15.6
Total	100	100	100
Average rate of interest	**11.67**	**25.20**	**17.00**

Table 5. Distribution of loans outstanding according to duration

Duration in years	Distribution of loans outstanding (%)
<1	45
1-2	20
2-3	14
3-4	6
4-5	5
5-10	8
0 & above	2
All	100
Average duration	**2.16**

Alley cropping- A way forward for sustainable agriculture

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Alley cropping, also known as hedge-row intercropping, is a relatively new agro forestry system, in which, arable crops are grown in alleys formed by trees or shrubs. The trees are kept pruned at lower height to avoid competition with field crops and the pruned biomass is recycled in the alleys for the purpose of erosion control, moisture and nutrient conservation. The technology has been tested in humid and sub-humid environments but its relevance for semi-arid India has been examined only recently. The National Policy on Agriculture (2000) of the government of India has also emphasized on adoption of agro forestry for nutrient management, nutrient fixation and organic matter addition. The benefits of alley cropping are fodder production and mulching with hedge-row pruning to increase crop production. This practice is thought to supply nutrients (especially N) for food crops through green leaf manure additions. Alley cropping with fast growing perennial leguminous trees holds a great promise for improving productivity of marginal lands in the rained drylands and hilly regions of India. Alley cropping system is the most appropriate answer for the marginal and degraded as well as under-utilized lands. *Leucaena* based alley cropping system not only recycles the nutrients but also improves the soil physical condition (Hazra, 1994). Hedge-rows formed by *Leucaena leucocephala* serve as factories for nitrogen fixation and provide litter biomass and improving soil properties (Tomar *et al.* 1992). **A**lley cropping has been recommended for the humid tropics primarily as an alternative to shifting cultivation and to improve soil fertility. In the semi-arid regions the main benefits of alley cropping are fodder production, mulching with hedge-row prunings to increase crop production. It is beneficial in terms of soil and water conservation with less run off and soil loss. The use of fast growing leguminous trees to supply nitrogen and organic matter, and to mobilize nutrients from deeper soil layers, helps to maintain soil fertility for longer in an extended cropping period, and to ensure

faster regeneration of fertility in a shortened fallow period. Alley farming appears to be a low cost sustainable agricultural technology and an alternative to the prevailing shifting cultivation and bush fallow system.

Alley cropping:

Alley cropping also known as hedgerow intercropping, in which food crops are grown in alleys formed by hedgerows of trees. The woody plants are cut regularly and leaves or twigs are used as fodder or mulch on the cropped alleys to reduce evaporation from the soil surface, suppress weeds and add nutrients and organic matter to the top soil. It is an agroforestry practice in which perennial, preferably leguminous trees or shrubs are grown simultaneously with an arable crop. Hedgerows are cut back to prevent shading, the pruned foliage is allowed to decompose to release nutrients. The planting of two or more sets of single or multiple rows of trees or shrubs at wide spacing, creating alleys within which agricultural, horticultural, or forage crops are cultivated.

Classification of alley cropping:

According to the purpose for which the alleys are raised, may be grouped into-

- Forage alley cropping
- Green manure-cum-mulch alley cropping
- Forage-cum-mulch-alley cropping
- Forage-cum-green manure alley cropping

Forage alley cropping: In this system both yield of crop and forage assume importance. *Leucaena* and Sesbania are recommended for hedgerow while Pigeon pea or caster crops are suitable for growing in the allies. Forage alley cropping is recommended as an alternate land use system for semi-arid regions as it provides green fodder during dry season.

Forage cum mulch system: In this system hedgerows are used both for forage as well as mulch purpose. Lopping is used for mulching during the crop season.

Green manure-cum-mulch alley cropping; In this system hedgerow prunings are used as green manure as well as mulch.

Forage-cum-green manure alley cropping: In this system the twigs and leaves are used both for fodder and green manure purpose.

Choice of tree species

The choice of tree species for alley cropping is extremely important because it determines the success or failure of the system. The important attributes for selecting a tree species for alley cropping are-

- Rapid growth rate,

Fig.1 Alley cropping system of Agroforestry

- Ability to withstand frequent cutting,
- Good ability to regrowth after cutting,
- Easy multiplication and establishment from seeds or cuttings,
- High nitrogen fixing capacity,
- Deep-rooting capacity,
- Different root distribution from the crop,
- Multiple uses such as forage and firewood,
- Ability to withstand environmental stresses such as drought, waterlogging, and extremes of pH,
- High leaf to stem ratio,
- Free from pests and diseases.

Suitable tree species for alley cropping

- *Leucaena leucocephala,*
- *Sesbania sesban*
- *Cassia siamea,*
- *Gliricidia maculate*
- *Calliandra* spp.

Role of alley cropping:

1. Effect of alley cropping on nutrient cycling

Tree legumes have considerable potential for improving the N status of soils and increasing the quality of fodder for animal consumption. In majority of soils, levels of plant-available N are insufficient to satisfy plant requirements and therefore fixation of nitrogen occurs through the legume component. The suitable tree species which releases N, Ca and Mg rapidly includes *Gliricidia sepium*, *Leucaena leucocephala*, *Mucuna pruriens* etc.Different species of hedge-row trees contains significant amount of nutrient concentration in leaves such as *Senna siamea* leaves contain highest percentage of C as well as high C:N ratio, while nitrogen concentration was higher in *Leucaena* leucocephala leaves. The *Gliricidia sepium* leaves contains high concentration of P and K. Similarly, *Leucaena leucocephala* trees produces high amount of dry matter and total nitrogen from different parts. The application of *Leucaena* prunings can save nitrogen, recycles more nutrients and benefits the succeeding crop. When an annual crop is planted with the multipurpose trees, known as hedge row system produce more biomass and recycle more nitrogen and phosphorus compare to sole crop. The yield of maize, when alley cropped with *Leucaena leucocephala* and *Gliricidia sepium*, were higher compared to mono-crop maize due to contribution of N to the companion maize crop.

1.1 Alley cropping with *Leucaena leucocephala* – a case study

Alley cropping with *Leucaena leucocephala* introduction in hedge row intercropping has provided an excellent opportunity to meet the demand of organic matter and soil moisture conservation through hedge-row management and addition of pruned material to the soil. The shrubs and the trees grown in the hedge rows not only recycle the nutrients but also suppress the weeds and control erosion especially on sloping lands. At ICRISAT, Hyderabad, several experiments had conducted to test the hypothesis that addition of hedge-row trees to annual crop systems-

- Improves the overall productivity by exploiting the residual moisture and nutrients beyond the reach of anneal crops,

- Improves soil fertility and consequently crop yield by utilizing the prunings of the perennial trees as green manure and/or mulch, and
- Reduces soil erosion by providing a protective soil cover.

Table-1 Nutrients contained (average quantity) in the prunings of leguminous tree species used in hedgerow intercropping systems. (Szott *et al.*, 1991)

Tree Species	Nutrient contents per pruning (kg ha^{-1})				
	N	P	K	Ca	Mg
Cassia reticulate	72	7	37	25	6
Gliricidia sepium	64	5	37	22	8
Erythrina sp.	67	6	36	16	7
Inga edulis	62	5	24	15	4
Mean	66	6	33	20	6

The data in table 1 shows the average quantity of nutrients in the prunings of different leguminous tree species used in hedgerow intercropping systems. The N, P, K and Ca contents were high in case of *Cassia reticulate* while Mg content was high in case of *Gliricidia sepium* prunings. The values of nutrients indicate that these species if used under alley cropping system may fulfill some of the requirements of the nutrients.

2. Effect on soil properties

An important benefit of alley cropping is the addition of large amounts of organic materials which improves the soil physical, chemical and microbiological properties of the soils and hence increases the soil fertility. Several studies indicated the positive effects of alley cropping on fertility parameters such as organic C status, total N and extractable P contents over a range of climatic and soil conditions. It is proved that mulches from *Sesbania sesban, gliricidia* and *leucaena* are the effective sources of N for crops. Beside these alley cropping can reduce the downward displacement of nutrients.

3. Effect on soil erosion

The alley cropping significantly reduces runoff and soil erosion due to barrier effect of the hedgerows and the presence of prunings as mulch. Some effective species in this regard are *Gliricidia and Leucaena*.

4. Effect on weed suppression

Alley cropping system proves beneficial in controlling weeds by shading effect during fallow period. Some effective tree species for weed control are *Gliricidia, Lucaena* and *Cassia siamea.*

Benefits of alley cropping:

- Provides green fodder during lean period of the year
- Higher biomass production per unit area than arable crops
- Efficient use of off-season rainfall in the absences of the crop
- Additional employment during off-season
- Promotes biodiversity and crop diversity
- Improves the water quality and reduce erosion
- Improved crop performance due to the addition of nutrients and organic matter
- Less reliance on the use of chemical fertilizers due to nutrient cycling

- Improves the physical nature of the soil environment
- Microclimate modification
- Financial benefits to the farmers through constant income from crops and tree components
- Improved landscape aesthetics
- Utilization of idle growing area
- It can ameliorate the adverse effects arising out of certain management practices
- Tree rows act as a physical barrier for strong winds and reduces the erosion hazards
- provide forage, firewood or stakes from the hedgerow of the multipurpose tree legume
- Due to shading effect weed growth may reduce and hence helps in weed control

CONCLUSIONS

Alley cropping technology has been tested in humid and sub-humid environments but its relevance for semi-arid India has been examined only recently. The National Policy on Agriculture (2000) of the government of India has also emphasized on adoption of agro forestry for nutrient management, nutrient fixation and organic matter addition. The benefits of alley cropping are fodder production and mulching besides increase crop yield. Alley cropping with fast growing perennial leguminous trees holds a great promise for improving productivity of marginal lands in the rained drylands and hilly regions of India. *Leucaena* based alley cropping system not only recycles the nutrients but also improves the soil physical condition. The use of fast growing leguminous trees to supply nitrogen and organic matter, and to mobilize nutrients from deeper soil layers, helps to maintain soil fertility for longer in an extended cropping period, and to ensure faster regeneration of fertility in a shortened fallow period. The merits of alley cropping system make it an important conservation farming practice for small and resource-poor farmers. The system exploits moisture and nutrients deep in the soil profile. It permits nutrient recycling, improves soil structure, provides good soil erosion control and reduces the need for chemical fertilizers. Therefore, alley cropping appears to be a low cost sustainable agricultural technology and an alternative to the prevailing shifting cultivation and bush fallow system. Thus, it can be considered as an option for better tomorrow in the endeavour of achieving sustainability in agriculture production system.

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Botanical Pesticides

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Botanical insecticides are naturally occurring chemicals (**insect toxins**) extracted or derived from plants or minerals. They are also called natural insecticides. Organic gardeners will choose these insecticides in some cases over synthetic organic materials. Botanical insecticides have long been touted as attractive alternatives to synthetic chemical insecticides for pest management because botanicals reputedly pose little threat to the environment or to human health.

Botanical pesticides have many advantages over synthetic pesticides which includes:

i.) botanical pesticides in general possess low mammalian toxicity thus constitute least or no health hazards and environmental pollution,

ii.) there is practically no risk of developing pest resistance to these products, when used in natural forms,

iii). these causes less hazards to non-target organisms and pest resistance has not been reported except synthetic pyrethroids,

iv). no adverse effect on plant growth, seed viability and cooking quality of the grains and

v). botanical pesticides are less expensive and easily available because of their natural occurrence especially in oriental countries.

Properties of botanical pesticides are-

i) Highly unstable in light, moisture and air

ii) degrade rapidly with a few exceptions

iii) having quick knock down effect

iv) good insecticides against household and cattle pests.

v) they act quickly

Products containg these active ingredients must be registered for use by the Environmental protection agency (EPA) .

1) Pyrethrum and pyrethrins –

Structure -

Cinerin I $C_{20}H_{28}O_3$
Cinerin II $C_{21}H_{28}O_5$
Jamolin I $C_{21}H_{30}O_3$
Jamolin II $C_{22}H_{30}O_5$
Pyerethrin I $C_{21}H_{28}O_3$
Pyrethrin II $C_{22}H_{28}O_5$

It was first used in Iran round 1800 flea killer .It is the powdered, dried flower head of the pyrethrum is daisy,*Chrysanthemum cinerariaefolium*. (family compositae). Most of the world's pyrethrum crop is grown in Kenya. The active ingredients of pyrethrum are six esters : pyrethrin I and II,cinerin I and II, jasmoline I and II. Pyrethrins exert their toxic effects by disrupting the sodium and potassium ion exchange process in

insect nerve fibers and interrupting the normal transmission of nerve impulses. Pyrethrins insecticides are extremely fast acting and cause an immediate "knockdown" paralysis in insects. Despite their rapid toxic action, however, many insects are able to metabolize (break down) pyrethrins quickly. To prevent insects from metabolizing pyrethrins and recovering from poisoning, most products containing pyrethrins also contain the synergist, piperonyl butoxide (PBO). Pyrethrins are low in mammalian toxicity. Pyrethrins are more toxic to mammals by inhalation than by ingestion because inhalation provides a more direct route to the bloodstream. Exposure to high doses may cause nausea, vomiting, diarrhea, headaches, and other nervous disturbances. Repeated contact with crude pyrethrum dusts may cause skin irritation or allergic reactions. There is no single antidote for acute pyrethrin poisoning. Commercial pyrethrum product Pyrocon E2/20 are available in market.

2) Rotenone-

Structure- $C_{23}H_{22}O_6$

It was first used as an insecticide in the British Malaya in 1848 against a caterpillar. It is extracted from the roots of *Lonchocarpus* species in South America, *Derris* species in Asia, and also from several other related tropical legumes . *Derris sp* contains 5-9% and *Lonchocarpus sp* contains 8-11% rotenone. Rotenone is a powerful inhibitor of cellular respiration, the process that converts nutrient compounds into energy at the cellular level followed by paralysis and death. Rotenone is extremely toxic to fish and is often used as a fish poison(piscicide). It is effectively synergized by PBO or MGK 264. Although rotenone is a potent cell toxin, mammals detoxify ingested rotenone efficiently via liver enzymes. As with pyrethrins, rotenone is more toxic by inhalation than by ingestion. Exposure to high doses may cause nausea, vomiting, muscle tremor, and rapid breathing. Very high doses may cause convulsions followed by death from respiratory paralysis and circulatory collapse.

3) Sabadilla

Structure-

Cevadine: $C_{32}H_{49}NO_9$

Veratridine: $C_{36}H_{51}NO_{11}$

This is prepared from the ripe seeds of tropical lily plant , *Schoenocaulon officinale*(family- Liliaceae) It is also sometimes known as cevadilla or caustic barley. When sabadilla seeds are aged, heated, or treated with alkali, several insecticidal alkaloids are formed or activated. A crude mixture of the plant alkaloids from Sabadilla seed is termed as veratrine, which contain several alkaloids ,of which cevadine and veratridine are toxic to insects. In insects, sabadilla's toxic alkaloids affect nerve cell membrane action, causing loss of nerve cell membrane action, causing loss of nerve function, paralysis and death . It is effectively synergized by PBO or MGK 264. Sabadilla, in the form or dusts made from ground seeds, is the least toxic of the registered botanicals. Sabadilla can be severely irritating to skin and mucous membranes, and has a powerful sneeze-inducing effect when inhaled. Ingestion of small amounts may cause headaches, severe nausea, vomiting, diarrhea, cramps and reduced circulation. Ingestion of very high doses may cause

convulsions, cardiac paralysis, and respiratory failure and circulatory collapse.

4) Neem

Neem products are derived from the neem tree, *Azadirachta indica*, that grows in arid tropical and subtropical regions on several continents. The neem is bitter in taste and the bitterness is due to the presence of an array of complex compounds called triterpenoids or more specifically limnoids. Different limnoids have been isolated and identified in neem seeds are - Salannin,salannol, salannol acetate ,3-diacetyl salannin, gedunin, nimbinen ,azadiradion ,azadiractin , etc. The principle active compound in neem is azadirachtin. Seed are the main source of active ingredient of neem. . The product known as "neem oil" acts to suffocate insects .

In insects, neem is most active as a feeding deterrent, but in various forms it has different types of effect like antifeedant or phagodeterrent effect , oviposition inhibiting effect ,growth and metamorphosis inhibiting effect , effect on fecundity and egg sterility . It also serves as a repellent, prevents insects from initiating feeding . It disrupts the normal development interfering with chitin synthesis. Commercial formulations of neem are Margosan ,Neemark ,Neemrich ,Achook , Bioneem ,Neemazal etc. Bioneem offers broad range insect control. Its active ingredient Azadirachtin.

6) Nicotine -

Structure - $C_{10}H_{14}N_2$

It is an alkaloid found from the leaves of *Nicotiana tabacum* and *N. rustica* . Insecticidal formulations, 40% Nicotine sulphate has been mainly used as contact insecticide with marked fumigant action in the control of sucking insect . It affects the nervous system of insect and ultimately kills the insect. It competes with major neuro transmitter , acetylcholine by bonding with acetylcholine receptors at nerve synapses and causing uncontrolled nerve firing . Nicotine in pure form is extremely toxic to mammals and is considered a Class I (most dangerous) poison. Symptoms due to nicotine toxicities are extreme nausea, vomiting, excess salivation, evacuation of bowels and bladder, tremors , mental confusion, convulsions, and finally death by respiratory failure and circulatory collapse.

5) Citrus oil extracts : Limonene and Linalool

Crude citrus oils and the refined compounds d-limonene and linalool are extracted from orange and other citrus fruit peels. Limonene, a terpene, constitutes about 90% of crude citrus oil, and is purified from the oil by steam distillation. Linalool, a terpene alcohol, is found in small quantities in citrus peel and in over 200 other herbs, flowers, fruits and woods. The modes of action of limonene and linalool in insects are not fully understood. Limonene is thought to cause an increase in the spontaneous activity of sensory nerves. This heightened activity sends spurious information to motor nerves and results in twitching, lack of coordination, and convulsions. Massive over stimulation of motor nerves leads to rapid knockdown paralysis. Both limonene and linalool were granted GRAS (Generally Regarded As Safe) status by the United States Food and Drug Administration in 1965, At higher concentrations, however,

limonene and linalool are physiologically active and may be irritating or toxic to mammals.

6) Ryania -

It is prepared from the roots and stems of South American shrub *Ryania speciosa* . (family- Flacourtiacea). Its active ingredient is Ryanodine , an alkaloid . It acts both as contact and stomach poison. Ryania , if ingested is moderately toxic to mammal.

Other Herbal Repellents and Insecticides-

The most common essential oils used as repellents are the oils of **cedar, lavender, eucalytus, pennyroyal, and citronella**. They are used mostly on pets and humans to repel fleas and mosquitoes. With the exception of **pennyroyal**, these essential oils are thought to pose little risk to people or pets, though they should not be used above recommended rates .Oil of pennyroyal contains **pulegone** , a potent toxin that can cause death in humans at doses as low as one tablespoon when ingested. At lower internal doses it may cause abortion, liver damage, and renal failure. Citronella is sold mainly in the form of candles to be burned outdoors to repel mosquitoes .

(*a*) Nicotine, (*b*) Pyrethrin I , (*c*) Rotenone, (*d*) Cevadine, (*e*) Ryanodine

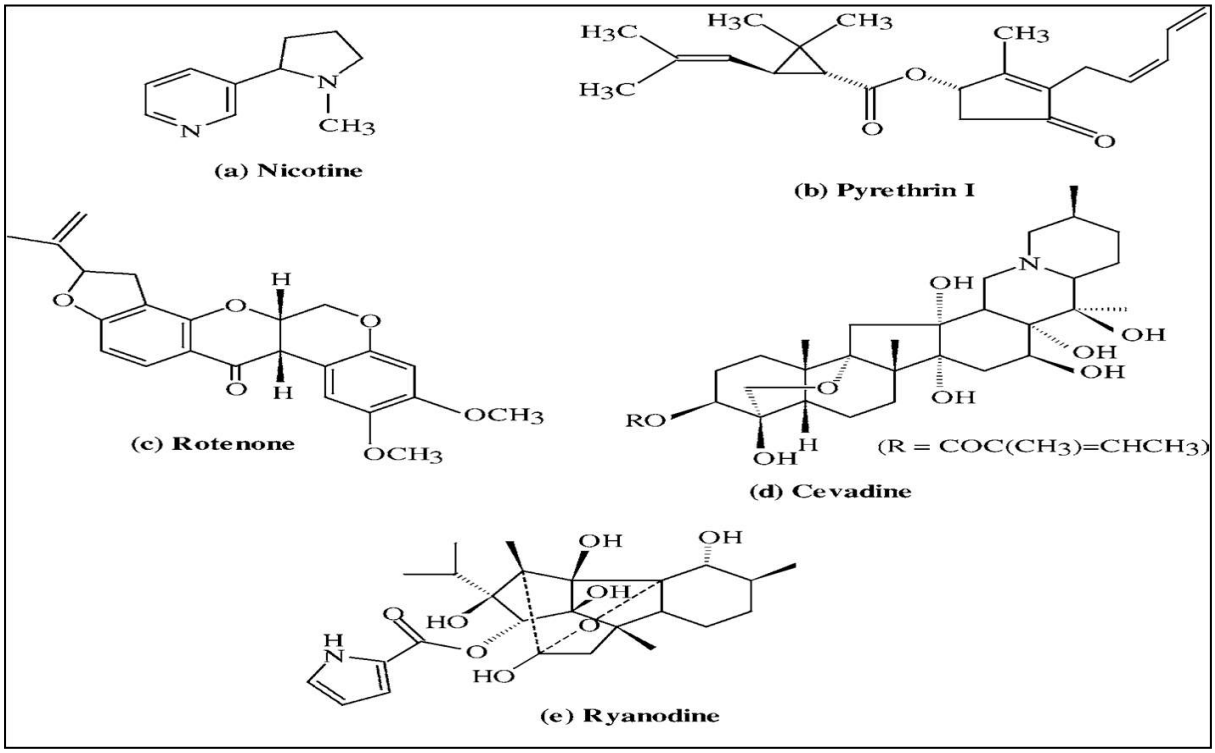
Future of botanical pesticides in agriculture can be emphasized in following two main directions:

(i) Search of flora for bio-pesticidal properties

Effective searching, isolation , identification and evaluation of active components of the plant products against common agricultural pests should be done keeping on mind their economics and biological effectiveness . the component should be synthesized in a easy method for commercial use .

(ii) Utilization of botanicals in pest management

Direct spraying of various plant extracts



for the control of soft bodied insect pests like aphids, jassids and also for caterpillars, soil amendment of plant materials like de-oiled cakes of neem, groundnut, sesamum, castor, mahua and karanj etc. controls soil inhabiting pests like white grubs and root-knot nematodes .intercropping/mixed cropping of the biologically active plants reduces the pest incidences eg : Intercropping of *Erica sativa* with mustard crop reduces the incidences of mustard aphids. Botanicals are used as grain protectants against storage insects pest . eg: vegetables oils like castor, sesamum, linseed, mustard and groundnut etc. effectively controlled the infestation of bruchids in pulse storage. Commercial or synthetic formulations of botanicals can also be used in pest management programme.

Eg. formulations based on neem and tobacco have already been registered in India. Several factors appear to limit the success of botanicals, most notably regulatory barriers and the availability of competing products (newer synthetics, fermentation products, microbials) that are cost-effective and relatively safe compared with their predecessors.

Crop diversification for sustainable food and fodder production

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Agriculture plays a vital role in food and fodder security in India and considered as an engine for growth. It supports nearly 83 per cent small and marginal farmers, 15.8 % semi medium and medium farmers while large farmers constitutes very small percentage. The food and fodder security is for the growing human and animal population is important at present on account of declining per capita land availability and is further declining due to fragmentation among the heirs. Beside this agriculture is facing climate change effects such as frequent droughts and floods problem, which drastically reduce food and fodder production. The productivity of major staple food grain crops viz., wheat and rice in Indo Gangetic plains have been reduced in the recent past largely due to climatic variations. Such changes in addition to low land availability and that too is subjected to so many problems viz., salinity, alkalinity and waterlogging poses serious challenges before the farmers, the researchers and planners to sustain the production for meeting the food requirement of the burgeoning population. Therefore, there is an urgent need to devise some strategies for sustainable crop production with diverse components so as to meet the nutritional and economic requirements of the farmers. In this context, crop diversification and crop intensification could provide some sustainable solution because green revolution era had focussed on mostly rice and wheat crops and crop rotation and sequencing principles were largely in favour of these two crops only. However, the need for diverse crops and cropping systems have felt in the recent past largely on account of ill effect created due to mono- cropping of rice and wheat. The declining factor productivity, per unit less production and more diverse food requirement calls the attention of researchers for diversified production system approaches, of which crop diversification proves a beneficial strategy towards enhancing and stabilizing productivity, making Indian agriculture export competitive and increasing net farm income and thereby ensuring economic security. Crop diversification is a very common feature in Indian agriculture now a day to ensure

stable production, income and employment at regional, national and global scale.

Concept of crop diversification

The crop diversification concept is largely relying on the shift of a crop or cropping system by another crop or cropping system, which utilizes the resources in best possible way by changing and modifying the degree, trend and time options of crop or cropping activities. The shifts in crops and cropping systems is mainly from less profitable and sustainable crop or cropping system to more profitable and sustainable crop and cropping system**.** Therefore, crop diversification is a feature of cropping systems which assists in achieving sustainable productivity by allowing farmers to employ biological cycles that minimize inputs, maximize yields, conserve resource base and also reduce risks due to both environmental and economic factors. Thus, crop diversification can be defined as a shift from the regional dominance of one crop to regional production of a number of crops, to meet ever increasing demand of cereals, pulses, vegetables, fruits, oilseeds, fibres, fodder, grasses etc. It intends to promote sustainable agriculture and enable farmers to choose crop alternatives for increased productivity and income.

Approaches to crop diversification

Crop diversification approaches generally involves utilization of land for cultivation of suitable multiple crops such as short duration vegetables and legume forage besides crops so as to ensure food and fodder security with balanced nutrition for human and animal being. Long term diversification can be achieved through integration of agroforestry component in crop production, which not only helpful in achieving full land utilization but also ensure better livelihood, employment and environment sustainability besides restoration of soil fertility and increasing per unit land productivity. Beside long and short term diversification approaches, there are development approaches which can be land and water based approaches. In addition to these, there is one more approach for crop diversification is increase crop output approach, which includes horizontal and vertical approaches. The former approach involves the crop substitution and crop intensification whereas the later relies on the inclusion of livestock, agro-forestry, horticulture particularly the post harvest and value added products. Crop diversification which could be achieved through various forms of growing crops under various cropping systems such as multiple cropping systems- sequence cropping (Double, Triple and Quadruple cropping system) and intercropping (Mixed cropping, Row cropping, Strip cropping, Relay cropping).

Determinants of crop diversification

A. Resource endowments which includes agro climatic conditions, soil, labour and irrigation facility.

B. Technological factors

C. Household factors

D. Institutional and Infrastructural factors

E. Price factors

Crop diversification-Why it is essential under Indian conditions?

Crop diversification under Indian conditions holds well on following counts

- It is helpful in raising farm income
- It ensures sustainable crop production and income

- It will help in achieving food and nutritional security
- It will increase the chances of export promotion of different commodities
- It can generate employment opportunities for the farmers and landless labourers
- It will help in poverty alleviation through constant income generation from diverse sources
  - It ensures judicious use of land and water resources besides labour and capital resources
  - It will help in reduction of environmental pollution

Harfindahl-Hirschman's Index (HHI) values for crop diversification

The HHI values for crop diversification for various states of India are presented in the table-1, which indicates that Karnataka, Maharashtra, Kerala and Rajasthan are highly diversified states. HHI values for Meghalaya, Andhra Pradesh and Madhya Pradesh indicated that these are moderately diversified states while, Mizoram, Manipur and Tripura are less diversified states in crop component (Saha, 2013). The grouping of the states was based on the interpretation of the data according to the criteria laid down in HHI for various crops. The interpretation envisaged that, if the HII index < 0.150 than the region will be considered as highly diversified, the values between 0.150-0.300 indicates moderately diversified regions while, the values > 0.300 shows the less diversified regions. A value of (+1) indicates completely specialized system while, the negative value (-1) is indicative of completely diversified system.

Table1 Harfindahl-Hirschman's Index values* for different states for crop diversification

Sr. No.	State	1990	2008-2009
1	Karnataka	0.094	0.106
2	Maharashtra	0.168	0.119
3	Kerala	0.155	0.132
4	Rajasthan	0.163	0.133
5	Meghalaya	0.356	0.160
6	Andhra Pradesh	0.218	0.175
7	Madhya Pradesh	0.139	0.177
8	Mizoram	0.532	0.562
9	Manipur	0.810	0.575
10	Tripura	0.500	0.721

**Values based on data of statistical abstract of India, 1991& DAC, GOI, 2008-2009*

Data in table 2 indicates that mono-cropping of groundnut, sunflower and maize was the predominant cropping system in the Chitradurga region. The introduction of castor and pigeon pea intercrops in these crops resulted into additional income over the existing mono cropping system. The income from existing cropping system ranged from Rs.11300-18,650 per acre whereas due to improved practices the income range increased to Rs.14100-23,833 per acre. The income rises from a very low (19 %) in case of Groundnut+Castor (8:1) intercropping to as high as (65%) in case of Groundnut+Pigeon pea (8:2) intercropping system. Thus, crop diversification ensures the increased income for the farmers.

Table 2 Economics of various improved cropping system *(NAIP, 2011)*

Cropping practices introduced	Yield (kg) /Acre		Income (Rs.)/Acre		Increase in income (%)
	Existing practice (Mono cropping)	Improved practice (inter cropping)	Existing practice (Mono cropping)	Improved practice (inter cropping)	
Groundnut+ Pigeon pea (8:2)	350	325+230	11300	18650	65
Groundnut+ Castor (8:1)	370	300+150	11860	14100	19
Maize+ Pigeon pea(6:1)	1830	1815+170	18006	23833	32
Sunflower+ Pigeon pea(2:1)	500	375+225	11700	17100	46

CONCLUSION

Crop diversification or crop shift is a new paradigm of sustainable agriculture. It is a shift from traditional and less remunerative crop(s) to more remunerative crop(s) besides, it is also demand driven, need based, situation specific, national goal seeking, continuous and dynamic concept, which involves spatial as well as temporal resource complementary and value addition approaches. However, crop substitution and addition of more crops in existing cropping system has been the major approach of diversification in India. The crop diversification mainly practiced from low value coarse cereals to high value oilseeds and other food grains.

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Castration, Handling and Clipping of Needle Teeth in Piglets: A Golden Key of Good Pig Farm Management

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CASTRATION

Castration, the removal of the testicles, is done on a male pig that is not needed for breeding. Castrated pigs are quieter and easier to handle. They become fatter than boars (male pigs used for breeding), and they produce meat that does not have a strong smell (boar taint). Boar taint, the unpleasant smell that sometimes arises when the meat of boars is heated, makes boar meat unsuitable for human consumption as fresh meat. (The meat can however still be used for processed meat products.) To avoid this problem, it is the current practice to surgically castrate male pigs in the first weeks of life. Pig farmers usually do these themselves and are allowed, by law, to castrate male pigs up to a certain age. Anesthesia is generally not used.

Good reasons for castration of pigs are:

- Boars often fight, causing injury to one another.
- Castrated pigs are quieter and easier to handle.
- A castrated pig will put on more fat.
- The meat does not have a strong unpleasant smell (boar taint)

Castrating the piglets

The best time to castrate young pigs is when they are 2–3 weeks of age. There are a number of ways to castrate pigs. The method described here is called the open method. This will need a very sharp, clean knife, razor blade or scalpel. It is best to use a new scalpel blade because these are sterile and very sharp. Hold the pig properly. The following things to be required:

1. Remove the sow from the litter. If possible, put her where she cannot see or hear the piglet.
2. Remove your watch and any jewellery. Germs under rings and watches could get into the castration wounds and cause them to become infected.
3. Wash your hands well with soap and water. Make sure your fingernails are cut short and are thoroughly clean, because germs under your fingernails can cause

infections.
4. Ask your helper to hold the pig by the hind legs and keep its head down while it is being castrated. Its body should be firmly held between the handler's knees.
5. Clean the scrotum with warm water and soap.
6. Wipe the scrotum with an antiseptic such as iodine.
7. Move the testicle into the scrotum with your finger. Then, using your thumb and index finger, firmly grip the scrotum below the testicle
8. Make a 2–3 cm (1 in.) cut in the bottom of the scrotum. The testicle should pop out of the scrotum. Do not put your fingers inside the scrotum.
9. Pull the testicle out of the scrotum and cut through the white cord. Leave the red blood vessel uncut.
10. Pull the testicle out slightly further and twist it around several times.

i) In young pigs, pull the entire testicle out to break the blood vessels.

ii) In older pigs, do not pull the blood vessel. Cut the twisted blood vessel by scraping

up and down with the knife. This helps to reduce bleeding.

iii) Remove the second testicle in the same way.

iv) Apply a tincture of iodine, gentian violet, antibiotic powder or sulpha powder to the

Caring for piglets after castration

It is very important to take proper care of castrated piglets:
1.Put the piglets and their mother on clean bedding.
2. Watch piglets for signs of infection in the wound for the next week. If a piglet does not want

to walk or is lame, this may be because of swelling in an infected castration wound.
3. If a piglet develops an infection in the castration cut, treat it as you would other wounds.

HANDLING

Pigs can be dangerous, but if the proper techniques are used they can be easily and safely handled.

Handling the young pig

Young pigs (**piglets**) can be picked up by hand. To lift piglets safely:
1. Catch the piglet from behind, and hold it by grasping the hind leg just above the **hock**. The hock is the ankle joint.
2. Place your other hand under the chest and pick up the piglet.
3. Support the piglet's weight against you when you are holding it.ific
4. Handled calmly and with care to prevent distress and injury to the animals and their handlers.
5. It must not be led by the head.
6. Drive the animal from behind by using an open hand to slap on the rump or flank region.
7. A straw broom or flapper used to tap the side of the neck will assist with directional change.

Handling is conducted for the specific reasons:

- Movement between barns for different phases
- Redistribution into larger or different pens
- Weighing
- Medicating animals

- Transport to market

Handling tips:

- Pateince
- Use a gentle demeanor
- Calm, deliberate movements
- Low noise
- Positive physical interactions (At least weekly)
- Think like a piglets.

CLIPPING OF NEEDLE TEETH

Pigs are born with eight deciduous teeth, called needle teeth or wolf teeth. Four of the

teeth are incisors and four are canines. Needle teeth serve to establish and maintain a level of dominance within the litter. From birth, pigs use their teeth to attain access to a teat. Within a few days after birth, each piglet in a litter has chosen a teat that it will always suckle. Usually the runt(s) in the litter will be forced to nurse from teats that do not produce a high quality or quantity of milk. If the teat is injured because of needle teeth, and loses its ability to produce milk, the pig will eventually die. The effect ripples from the injury to the sow, to the death of a pig, and finally to the farmer losing money. The results of their fighting are injuries across the face and neck. These injuries may affect the pigs' growth and wellbeing. Generally, clipping of the needle teeth is done within the first 24 hours after birth.

Approximately, one-half of each needle tooth is cut off using wire cutters or other sharp cutting tool, or the teeth may be clipped to the gum line. However, if there are ongoing problems in a herd, this procedure should be carried out within 3 days of birth. The teeth can be removed using a strong pair of nail clippers. Clippers should be disinfected, and, where possible, only the tips (top quarter) of the teeth should be clipped using sharp, clean clippers, without cracking the tooth or leaving sharp edges. Note that cutting a tooth flush with the gum provides another site for infection. The clipped needle teeth are later replaced by the pig's adult teeth.

Purpose of clipping: The purpose for clipping the needle teeth of piglets is to prevent injury to the sow's teats when her offspring nurse, as well as to prevent facial injuries to piglets as they compete for access to teats.

Protocol:

i)Secure equipment container in a safe and convenient location at first farrowing pen or hut.

ii) Place piglets in a holding container, either all together or a few at a time.

iii) Pick up piglet by back leg above hock or around hips.

iv)Cradle piglet firmly between operator's forearm and body.

v)Hold piglet's head still and mouth open using correct grip:

- Insert first finger at side of piglet's mouth to hold piglet's mouth open
- Place second and third fingers at angle to side of head
- Place the clippers parallel to the jawbone and gumline.

vi) Clip the tip of the front needle tooth on the closest side of the upper jaw

vii)Take care not to cut gum, lips or tongue and avoid exposing the pulp cavity

viii)Clip the tip of the rear tooth of the same pair

ix)Repeat process for the two lower teeth (one incisor, one canine) on the same side of the jaw
x)Adjust grip to access other side of piglet's jaw and repeat steps
xi)Check evenness of clipping by rubbing finger over clipped surface; make sure no sharp points of teeth are left, re-clip if necessary
xii)Check that the gum is clean
xiii)If grinding make sure you only blunt the tip rather than grind down a significant portion of tooth
xiv)Mark piglet and return to holding container or proceed with next piglet task
xv)Repeat above steps for remaining piglets, dipping clippers in disinfectant between piglets
xvi)On completion of litter return clippers to disinfectant dip
xvii)Complete sow litter record if applicable.

Equipments required:

- Teeth clipers/grinders
- Surgical disinfectant
- Dipping container
- Marker
- Piglet holding container
- Waist belt or carrying device
- Personal safety – safety glasses,ear plugs (Indoors),gloves and dust mask.

Side effects of needle tooth clipping:

Clipping has been shown to increase behaviors suggestive of discomfort such as "chomping." Piglets whose teeth have been clipped may experience more gum and tongue injuries and potentially painful inflammation or abscesses of the teeth. These injuries may lead to infections and increased time spent sleeping (seen as an indicator for infection).

CONCLUSION:

- Castration of piglets is very important from meat quality, handling of pigs and to attain highest marketable weight point of view.
- Handling of piglets is important managemental practice to prevent distress and injury to the piglets. Patience is needed during handling.
- Needle tooth clipping practice avoids teat injury to sow and facial injuries in between piglets.

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Potato Breeding and Variety Development

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Potato variety development is the most crucial aspect for increasing productivity of the crop in India for sustaining the increasing population pressure, my means of improving characters of economic importance. It involves the art and science of plant breeding, carrying out not only the right selection of parents but also the right selection of progenies, which are then evaluated over several years for not only consistent performance in terms of yield but also adaptation, dry matter, keeping quality, disease resistance etc. The benchmark for superiority over the best control has to be crossed each and every time, making it difficult for each new entry/ progeny to make to the winning line demarcated here as its release. India has made a significant achievement, standing as the second largest producer in the world after China for a non-native crop which originated in highlands of Andes, South America and introduced in India by Portuguese traders or the British missionaries in 17th century.

The major contribution for the same is attributed to the establishment of ICAR-Central Potato Research Institute (ICAR-CPRI) in 1949, which marked a new era for organized potato research in India. The activities of collection, conservation, evaluation and documentation of potato germplasm and its utilization became integral part of the research programmes of the institute. The crop witnessed tremendous increase in its production, area under cultivation and productivity in the country. As per FAOSTAT, the potato production in India during 2013 was 45.34 million tonnes from 1.99 million ha area with a productivity of 22.76 t/ha, which depicts an 8.5, 29.4 and 3.5 times growth respectively over the 6 decades of its organised research.

The major contributing force which led this revolution was the strongly organised varietal development programme which has evolved 51 different varieties having varying useful traits and maturity groups for different agro-climatic zones till date. The key to this quantum leap in potato production lay in the conventional plant breeding procedures involving plant hybridization. Early potato introductions in India were mostly *S. tuberosum* ssp *andigena,* bearing small, misshapen tubers with deep eyes, having low yield, and most importantly restricted to the cool long day climate of the mountains (Fig. 1). A lot of misperceptions regarding the

identity and nomenclature of these introductions existed which varied with dialects and regions, hence, a potato synonym committee was formed from National Institute of Agricultural Botany which led to identification and characterization of 16 non-European varieties, which came to be known as desi or indigenous samples or varieties, of these Phulwa, Darjeeling Red Round and Gola were most popular. Besides these 38 European varieties were also identified, which were referred to as the exotic varieties having limited adaptation to the Indian climate.

Figure 1: Here we are from where we were. Contrasting differences in yield, size, colour and shape of potato tubers over decades of improvement.

Varietal improvement programme involving plant hybridization was initiated at Kufri (Shimla), HP. With the perfection of seed plot technique in 1963, it became possible to raise, maintain and evaluate segregating populations of progenies (developed in hybridization carried out at Kufri), in the plains under disease-free low aphid periods. Thus establishing Indo-Gangetic plains as the major hub for potato seed production in India.

Although the genetics of the crop is highly complex, owing to its autotetraploid, heterozygous nature, the fixation of desirable genes is quite simple, as it is vegetatively propagated. The elegance and beauty of the technique lies in its simplicity and ingenuity of the breeder to identify the suitability of a parent for breeding (i.e. germplasm screening and parent selection) and the science of plant hybridization to produce progenies, unleashing the whole variability in the genetic constitution of the parents, in the form of true potato seeds (TPS). These TPS are then germinated, in the succeeding generation and the resulting tubers borne are evaluated for various economic characters, for upto three clonal generations. The promising ones after due evaluation with controls or varieties of proven economic value are included in multi-location yield trials and if found suitable are proposed for release. The whole process takes more than 10 years. The heterozygosity inherent to potato also requires the genotypic assessment of the germplasm, which makes it mandatory to carry out combining ability studies which of course is dependent on crossing/ hybridization and evaluation of progeny.

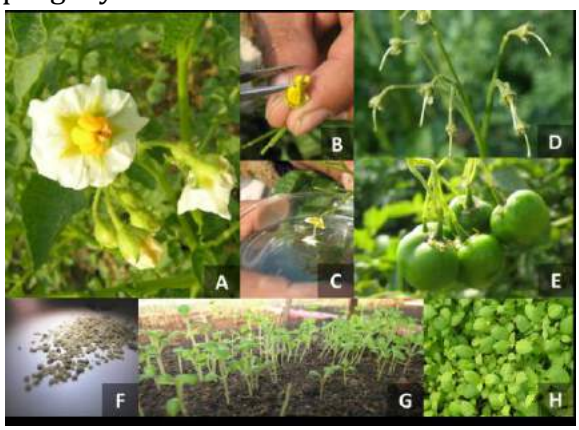

Figure 2: Potato Hybridization procedure. A: Flower on potato crop; B: Emasculation on potato mature and unopened flower; C: Pollination of emasculated flower; D: Pollinated flower bunch; E: Berry setting on pollinated bunch; F: True potato seed (TPS) extracte

Figure 3: Variability in potato leaf shape

Germplasm being the backbone of any successful breeding programme. ICAR-CPRI maintains a huge germplasm collection of more than 4200 accessions including cultivated-bred at CPRI, advanced hybrids, indigenous varieties, indigenous samples, exotic collections, andigena accessions, wild and semi-cultivated accessions maintained as *in vitro* plantlets, tubers and true potato seeds. Germplasm collection at CPRI demonstrates a whole array of variability in traits like tuber shape, size, flesh colour, flower colour, leaf shape and size etc. This germplasm collection has been evaluated for many economic characters like resistance to late blight, bacterial wilt, wart, nematodes, potato tuber moth, charcoal rot, stem necrosis, powdery scab, termite, mite, hopper burn, viruses, maturity, tuber yield, tuber dormancy, storage quality, tuber dry matter, protein content, frost tolerance, cold induced sweetening, processing attributes and adaptability under autumn, spring and kharif crop seasons. Besides commercial characters, the germplasm accessions have also been characterised for morphological characters like tuber skin colour, flower colour, flowering intensity, pollen fertility etc. The crop improvement programmes of ICAR-Central potato research Institute have contributed much to the present day vibrancy and resourcefulness of Indian Potato Industry. Much need to be added and spoken about the farming community which contributed in so many different ways to make this foreign food a household food of today. It has formed an integral part as not only being the end user for growing the released varieties for the masses but also to some extent in the development of the varieties and maintenance of germplasm. The early germplasm introductions to India, were maintained by farmer communities and these formed a part of the early germplasm collections of CPRI which were used in early breeding programmes by the plant breeders. Some farmers in India have been proactive in the development of varieties and have been selling the same as seed in the market. Even the Protection of plant varieties and Farmers' Rights Act has identified and

recognized the role of farmers in maintenance of Farmers' varieties on the farmers field, which are of local importance and possess genes of economic interest. Farmers in actual sense may be considered as the prehistoric plant breeders instrumental in development of varieties of any crop. The seed from the best selections were retained for growing in the next cropping season, unknowingly practicing selection for various traits, which of course is defined as the art aspect of plant breeding. It is only in recent past that coordinated efforts on developemnt of varieties was initiated by plant breeders using the Science of plant breeding.

Figure 4: Variability in potato flowering

Although, this concept of Participatory plant breeding is well known, it has had a limited adaptation in variety development and release life cycle in India. In the Andean region of South America, generations of farmers have domesticated thousands of potato varieties. Even today, farmers cultivate up to 50 varieties on their farms. In the biodiversity reserve of the Chiloé archipelago in Chile, local people cultivate about 200 varieties of native potato. They use farming practices transmitted orally by generations of mainly women farmers. The farmers of the region are proactive in maintenance of potato varieties of traditional importance. A potato park has been established by collaboration between the government and farmers for maintenance of the germplasm resources. Adoption of similar mechanism and top up programmes of plant breeding for potato improvement would definitely stimulate better output.

Potato breeding for variety development can be made more prolific by merging the two concepts of Art and Science, which can ideally be brought together by the farmers and the scientists working together in development of varieties and maintenance of germplasm of potato or any other crop.

Figure 5: Variability in tuber shape, tuber colour and flesh colour

Rhizospheric competency of mycorrhiza with other bio-agents in management of major soil-borne plant pathogens

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Abstract

Mycorrhiza is a symbiotic association of fungi with roots of higher plants in which it helps the plant in many ways by enhancing phosphorous uptake, water uptake, nitrogen fixation, trace nutrients availability, antibiotics and hormone production and reduces pathogen inoculums in rhizospheric region of plant roots by applying many mechanisms such as physical, physiological, biological and biochemical mechanisms and protects plant roots from the attack of various soil-borne plant pathogens alone and in interaction with other bio-agents. This article will be helpful for providing knowledge about how mycorrhiza works in the rhizospheric region with other bio-agents in management of major soil-borne plant pathogens.

INTRODUCTION

Mycorrhiza is one of the major components of the agricultural natural resource and they are members of the Kingdom: Fungi; Phylum: Glomeromycota. Soil-borne plant pathogens such as fungi, bacteria and nematodes incurred a great economic loss to the agricultural productivity. For management of these problems, an extensive uses of chemicals for control of diseases pose a serious threat to the present day sustainable crop production systems (Dehne, 1982). The use of beneficial microorganisms is one of the alternative management strategies to have protective measures against soil-borne pathogens (Mukerji *et al.,* 2002). Therefore, many researchers are trying to use alternate approaches based on either manipulating or incorporating microorganisms to strengthen plant protection umbrella against soil-borne pathogens (Grosch *et al.,* 2005). When these bio-agents are applied along with arbuscular mycorrhizal (AM) fungi, it gives better reduction in soil-borne plant pathogens (Smith and Read, 2008) and boost up the crop growth (Schreiner and Bethlenfalvay, 1995) involving several mechanisms.

What is Mycorrhiza?

The word Mycorrhiza originated from the Greek word "*Mykes*" means "fungus" and "*Rhiza*" means "roots". Mycorrhiza is a symbiotic or feebly pathogenic association of fungus and roots of higher plants. The term "mycorrhiza" was

coined by Albert Bernhard Frank to describe the symbiotic association of plant roots and fungi in 1885. It consists of vesicles, arbuscules, hyphae and spores. Vesicles are spherical or oval thick walled structures and acts as a storage structures. Arbuscules are bush-like haustoria and performs function in absorbing the nutrients from soil. Hypha is of thick-walled or permanent and thin-walled or short-lived. It bears various kinds of spores (Dube, 2015).

Types of mycorrhiza: 1. Ectomycorrhiza (Ectomycorrhiza), 2. Endomycorrhiza (Erichoid, Orchid and Vesicular arbuscular mycorrhiza) and 3. Ectendomycorrhiza (Arbutoid and Monotropoid mycorrhiza) (Dube, 2015).

Hyphal network: Two types: The *Paris*-type (Intracellular) and *Arum*-type (Intercellular) (Dickson, 2004).

Functional diversity of AM fungi: It increases efficacy of N_2 fixation in legumes, overall absorption capacity of roots, mobilization and transfer of nutrients, tolerance against root pathogens by plants, production of plant growth hormones, and secretion of antibiotics and adaptation of plant to adverse environmental conditions (Garg and Chandel, 2010). **Mechanism:** An AM fungus shows several mechanisms which are involved in the suppression of the soil-borne plant pathogens. 1. Physical 2. Physiological 3. Biochemical and 4. Biological mechanism (Sharma and Johri, 2002).

1. Physical mechanism: Lignifications of the cell wall and production of other polysaccharides has been reported to prevent penetration of *Fusarium oxysporum* (Dehne and Schoenbeck, 1979). It imparts great mechanical strength and diminishes the effect of vascular pathogens through a stronger vascular system of the mycorrhizal plants by increasing the nutrients flow (Schoenbeck, 1979).

2. Physiological mechanism: AM fungi indirectly affect host-pathogen relationship through competing for space or host resources (Smith and Gianinazzi, 1988). Higher levels of amino acids (arginine) in combination with root exudates of mycorrhizal plants have been reported to reduce chlamydospore production of *Thielaviopsis basicola* (Baltruschat and Schoenbeck, 1975). Higher concentrations of orthodihydroxyphenols in mycorrhizal plants resulted in suppression of *S. rolfsii* (Krishna and Bagyaraj, 1986).

3. Biochemical mechanism: Increased production of phytoalexins such as coumesterol supports mycorrhizal symbiosis and inhibits the activity of plant pathogenic fungi (Ross, 1972). Roots of host plants colonized by a mycorrhizal fungus exhibits high chitinolytic activity in which PR proteins like chitinase and ß 1-3 glucanases hydrolyzes the carbohydrate and chitin contents of the pathogenic fungi (Boller, 1993).

4. Biological mechanism: The interaction between AM fungi and other soil microbes in rhizosphere can be positive or negative (Mukerji *et al.,* 2002). The positive interaction of AM fungi with plant growth promoting rhizobacteria (PGPR) and N_2- fixing bacteria enhance the spore germination of AMF and the plant growth (Mayo *et al.,* 1986). Negative interaction is related to the ability of AMF to suppress and inhibit the various pathogens (Dehne, 1982).

Interaction of mycorrhiza with rhizobacteria in biological control: Several bacteria such as *Pseudomonas* spp., *Bacillus* spp., *Paenibacillus* spp. and *Rhizobium* spp. survive in rhizospheric region of host plants. In host plants, rhizosphere carbon flow is greatly affected by the presence of mutualistic arbuscular mycorrhizal fungi. Carbon from AM fungal mycelium is rapidly incorporated into microbial biomass and so these fungi have the potential to be important conduits of energy into rhizosphere bacteria that have bio-control potential (Siasou *et al.,* 2009). These rhizosphere bacteria have capacity to produce the antimicrobial secondary metabolite 2, 4- dicetyl-phloroglucinol (DAPG) (Cook, 2003). DAPG is broad range antibiotic with antibacterial and antifungal properties (Thomashow and Weller, 1996). Thus, it protects the roots of host plants from the infection caused by soil borne plant pathogens. Ambardar (2011) reported that application of *Glomus mossae* (Gm_1) with *P. fluorescens* and *B. cereus* recorded 19.99 and 20.00 per cent bacterial wilt incidence, respectively in tomato (cv. Solan Gola) compared to control (91.66%). While, in case of BWR-5 cultivar the same treatments found significantly superior over all other treatments in which no incidence of bacterial wilt was recorded. Zahid *et al.,* (2007) found that application of VAM fungi along with *Rhizobium* sp. gave significantly lowest mortality (20.84 %) of chickpea seedlings incited by *Sclerotium rolfsii* as compared to control (100%).

Interaction of mycorrhiza with *Trichoderma* spp. in biological control: Vazquee *et al.,* (2000) reported that AM fungi and *Trichoderma* spp. both promoted the plant growth and improved health when they colonized roots and facilitated them in a synergistic manner. *Trichoderma harzianum* induces the symbiotic association of AM fungi with vascular plants. Al-Asbahi (2012) showed that volatile biomolecules released by *T. harzianum* Rifai indirectly enhanced association of AM fungi with host plant roots. Haneefat *et al.,* (2012) reported that Auxin and Gibberllin levels were accumulated significantly in soybean plants when treated with *T. harzianum and Glomus mosseae*. Leta and Selvraj (2013) showed that application of *Glomus aggregatum* along with *T. harzianum* isolate (ATh1) resulted into lower white root rot (*Sclerotium cepivorum* Berk) incidence (33.81%) compared to control (90.50%) in onion. Dehariya *et al.,* (2015) concluded that application of *T. harzianum* and mycorrhiza in pre-inoculation method found effective in managing Fusarium wilt (*Fusarium udum*) of pigeonpea.

Conclusion: Mycorrhiza is ubiquitous in nature and can be effectively used for biological control of soil-borne plant pathogens as it has several mechanisms for suppression of the pathogen. Among all species of mycorrhiza, *Glomus* spp. is most widely used and found effective for biological control. Use of AM fungi is an effective alternative in biological control as it protects plants roots from soil-borne plant pathogens in rhizosphere. It gives better results in interaction with bio-agents such as *P. fluorescens* and *Trichoderma* spp. against soil-borne plant pathogens as compare to alone. It plays a major role in plant protection as well as in plant growth promotion.

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Allele Mining: An Approach to Crop Improvement

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Genetic resources and wild relatives are considered to be a major source of superior and beneficial allelic variations (i.e. polymorphism). Minute changes, even a single nucleotide change at DNA sequence level (i.e., difference in allelic structure) is a main reason behind any generic polymorphism in crop species. These polymorphisms have been taken into advantage by plant breeder since binging, knowingly or unknowingly. Plant breeders bring improvements in crop in term of superior and high yielding verities by accumulating beneficial allelic variations in a narrow genetic background. A major part of these superior alleles (alternate forms of gene at particular locus on chromosome) are not in use, as these allelic variations had been left behind by us in the course of evolution and domestication.

Allele mining helps in exploring the variations at DNA sequence level and to find out the superior alleles in diverse genetic resources. This is an effort to isolate the superior alleles from a vast and wild generic background and, their introgression to cultivated one. In simple words, this can be understand by keeping the word 'Mining' in mind, where we extract non-renewable and valuable sources from earth. Similarly, in allele mining efforts are done in finding out the superior and beneficial alleles on the basis of sequenced level polymorphism from a natural population to introduce them into a cultivated population, artificially.

The new allelic variations are the result of mutations. These mutations are non-lethal and expressive. Thus mutations give raise to new alleles, due to insertion/deletion (In/Del), duplication, translocation, inversion or change in single nucleotides (SNP).

Initially only coding regions (exons) of a gene were use to study in allele mining since these regions are directly indulge in the synthesis of the proteins resulting the phenotypic expressions. Later, ample examples were found, proving that, not only coding regions, the non-coding regions (introns), 5' UTR and 3'UTR regions also play important role in synthesis of proteins. The procedures, involving the study of exons, introns, 5' and 3'UTR altogether, referred as true allele mining.

Requirement of large scale allele mining

- ✓ Ensuring the richness of biodiversity
- ✓ Large number of diverse genotypes
- ✓ Gene and genome sequencing information
- ✓ Detailed characterization of the germplasm lines.
- ✓ Use of modern tools of genomics

✓ Cost effective genome sequencing techniques

✓ Adequate funding support and infrastructure

APPROACHES

Two major approaches are available for the identification of sequence polymorphisms for a given gene in the naturally occurring populations. They are (i) modified TILLING (Targeting Induced Local Lesions in Genomes) procedure called EcoTilling and (ii) sequencingbased allele mining. A brief description of these two approaches is given in this section and steps involved in these approaches are illustrated in Fig. 1.

1. EcoTILLING- based allele mining: Targeting Induced Local Lesions in Genome *i.e.,* TILLING, helps in the determination of artificially induced mutations (Comai *et. al.*, 2004) especially in point mutations. TILLING allows the identification of allelic variations in high-throughput manner. TILLING technique used in the identification of natural variations in gene sequences is called EcoTILLING. Random point mutations are induced artificially in seeds by using mutagenic chemicals (e.g., EMS). The mutations are then screened in M_2 seeds (progenies of selfed M_1) of single seed decent (SSD) progenies. For screening, DNA(s) are pooled eightfold to maximize the efficiency of mutation detection. PCR is performed using 5'-end specific primers to target the desired locus, and heteroduplex are formed by heating and cooling the PCR products. Nuclease enzymes (e.g., S I nuclease) are used to cleave at base mismatches, and products representing induced mutations are visualized with denaturing PAGE. The detailed procedure has been given by Till, *et al*. (2003). (*fig. 1*)

2. Sequenced-based allele mining: variations in the nucleotides are traced by DNA sequencing. This involves, identification of polymorphism by using gene specific markers (e.g. SSR and In/Del), then the amplification of specific DNA segment in RT-PCR and their sequencing by using various sequencing platforms , such as SoLiD, Illuminaa/Sonax Genome Analyzer™ etc. (*fig.1*)

CHALLENGES

- Selection of genotypes
- Development of core collection
- Accurate phenotypic methods
- Flexible computational tools
- Handling genomic resources
- Demarcation of promoter region
- Characterization of regulatory region
- Higher sequencing costs

Unlike EcoTALLING, sequence based allele mining is much cheaper and less sophisticated process, as it do not need hectic process of inducing artificial mutations, generation of M_2 seeds in SSD method and requires comparatively less chemicals.

Various sophisticated software and bioinformatics tools viz., PLACE, plantCARE, TRANSFAC, JASPAR, MEME, Plantprom DB, DCPD, SCPD, BioEdit, ClustalW etc. are required for handling the complex nucleotide data, identification of sequence polymorphism and the comparison and alignment of our genome sequence to reference genomes.

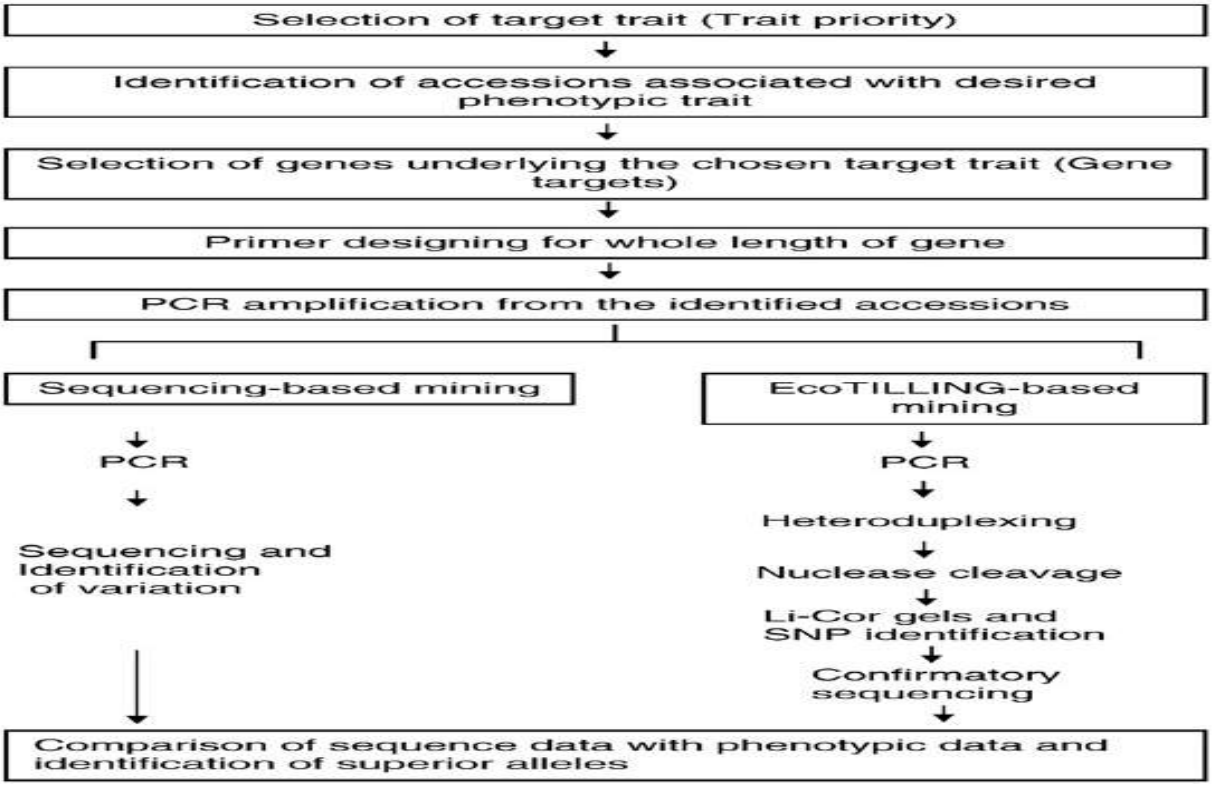

Fig.1 Steps Involved in Allele Mining

Applications of Allele mining: Allele mining can successfully be used in discovery of superior alleles by 'mining' the gene of interest. It can be potentially use in development of functional molecular marker assisted selections (MAS), identification of new haplotypes, evolutionary studies and similarity analysis between inter or intra species.

CONCLUSION

Allele mining can be visualized as a potential technique in utilizing the genetic and genomic resources for crop improvement. Costlier sequencing techniques and highly skill based procedures become a limiting factor for this. More efforts are to be made in developing simple strategies of sampling genetic resources within less number of genotypes and handy computational tools.

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Fundamentals of Artificial Insemination in Cattle and Buffalo

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Artificial insemination (AI) is the process where semen is deposited in the female reproductive tract by mechanical methods at the proper time and under most hygienic conditions during natural or induced estrus. The first scientific research in AI of domestic animals was performed on dogs in 1780 by the Italian scientist, Lazzaro Spallanzani. His experiments proved that the fertilizing power resides in the spermatozoa and not in the liquid portion of semen. Artificial insemination is not merely a novel method of bringing about impregnation in females. Instead, it is a powerful tool mostly employed for livestock improvement. In AI, the germplasm of meritorious bulls with acceptable or excellent quality can be effectively utilized with the least regard for their location. By adoption of AI, there would be a considerable reduction in both genital and non-genital diseases in the farm stock.

Advantages of A.I.:

There are several advantages by artificial insemination over natural service:

- There is no need to maintain breeding bull for a herd; hence the cost of maintenance for breeding bull can be saved.
- It prevents the spread of venereal diseases.
- By regular examination of the semen after collection, early detection and elimination of inferior male can be succeeded.
- The progeny testing can be done at an early age.
- The semen of the desired sire can be used even after the death of that particular sire.
- The semen collected can be taken to the urban areas or rural areas for insemination.
- It makes possible the mating of animals with great differences in size without injury to either of the animal.
- It helps in better record keeping.
- Old, heavy and injured sires can be used.

Semen collection methods and evaluation:

Various methods of collection of semen have been devised from time to time. The older unsatisfactory methods have gradually replaced by the new modern

techniques. There are three common methods:

- Use of artificial vagina.
- By Electro-stimulation method.
- By massaging the ampulla through the rectal wall.

The ideal method of semen collection is the use of artificial vagina, both for sire and collector.

SEMEN STORAGE

The discovery that bull semen could be successfully frozen and stored for indefinite periods has revolutionized AI in cattle. In 1949, British scientists discovered that addition of glycerol to the semen extender improved the resistance of sperm to freezing. Glycerol acts to remove water from the sperm cell prior to freezing and prevents the formation of cellular ice crystals which would damage the sperm. There are two methods of freezing and storing semen: dry ice (-79°C) or alcohol (-100° F) and liquid nitrogen (-320° F). Liquid nitrogen is preferred because there is no evidence of fertility deterioration with time. Fertility gradually declines for semen stored in dry ice and alcohol.

Frozen semen can be stored indefinitely if proper temperature is maintained. Recently, a calf born from frozen semen stored for 16 years has been reported. Fresh, liquid semen can be successfully stored for 1 to 4 days at 40° F. Storage of semen in mini French straw have been adopted exclusively by many AI organizations. Artificial colors are frequently added to semen extenders in order to distinguish one breed from another. Complete identification of the bull is required on each individual semen container.

Symptoms of heat

The various symptoms of heat are restlessness and nervousness, frequent bellowing, micturition, homosexual mounting in case of cows, clear cervical mucus discharge, edema and congestion of the vulva. The tail will be in raised position. A reduction in the milk yield and tonicity of the uterus are also seen.

INSEMINATION METHODS

There are different methods of insemination in large ruminants:

- Speculum method,
- Vaginal method and
- Recto-vaginal method.

Recto vaginal method

In cattle, the safe and best method of insemination is “Recto-vaginal method of insemination”. Cow, in heat is well controlled placing in a travis. The inseminator gets ready by wearing a plastic apron, gumboots and gloves. The semen straw after thawing (keeping the semen straw in warm water for a minute) is loaded in a sterilized A.I. gun and is covered with a plastic sheath. The inseminator then inserts gloved left hand into the rectum after applying the soft soap or any other lubricant on the glove and back racks the animal, and the hand is further inserted to catch hold the cervix through the rectal wall. The A.I gun loaded with semen straw is passed through the vulva to vagina and cervix and observed with the hand in the rectum that the A.I. gun crosses the external os of the cervix; the semen is deposited at mid cervix by injecting the gun, after that gun is removed and empty straw and sheath are discarded.

Speculum method

In this method, a speculum is placed in the vagina of the cow, which provides passage outside to the site of insemination, then the inseminating tube is passed through the speculum and semen is deposited at the cervix.

Vaginal method

The hand is passed through the vagina and the inseminating tube is guided by hand to the site of insemination and semen is deposited. This method has a risk of contamination and injury of female genitalia.

Timing of insemination for maximum conception

A frequent question concerning AI is: What is the right time during estrus at which cows be bred for the greatest chance of conception? Since estrus may last from 10 to 25 hours, there is considerable variation in possible time of insemination. Much research work has been conducted on this subject. Controlled investigations were conducted by Trim Berger and Davis at Nebraska in 1943. There and other studies show that conception rate is lower when cows are bred prior to mid-estrus or later than 6 hours after cessation of estrus (standing heat in this case). Maximal conception is obtained when cows are inseminated between mid-estrus to the end of standing estrus, with good results up to 6 hours after estrus.

Success in insemination timing is dependent upon a good heat detection program. In large herds, this means assigning individual responsibility for heat detection and a continued education program for labor. A successful heat detection program and subsequent proper timing of insemination will pay dividends in increasing reproductive efficiency. A practical recommendation for timing of insemination:

Cows in estrus	Right time of AI	Too late for good results
In morning	Same day evening	Next day
In afternoon	Next day morning	After 3 p.m.

Buffalo

Water buffalo are seasonally polyestrous (Sep to March) with an average cycle length of 21 days (ranging 18–24 days) with an average duration of estrus of 18 h (range 5–36 h). Compared to cattle, estrus behaviour in water buffalo is much more subtle, and homosexual behaviour, i.e. females mounting females, is rare. Frequent micturition, cervical mucus discharge, swollen vulva and reddening of the vulvar mucosa are the reliable indicators of estrus. Ovulation occurs 30 h after the onset of estrus (range 18–45 h).

ESTRUS DETECTION

Covert or silent estrus is a cause of poor reproductive efficiency in the buffalo. Estrus detection is a pre-requisite for efficient reproductive management. To compensate for the lack of overt estrus behaviour among female, estrus can be detected with the aid of teaser animals, or pedometers, or it can be induced by hormonal treatments. Teaser animals can be bulls with a lateral deviation of the penis or epididymectomy or androgenized females. Vasectomized bulls are less desirable due to the risk of spreading venereal diseases. Teaser animals should be fitted with a chin-ball marking device to identify the animals in estrus.

A.I. in buffalo

The optimal time for insemination is 8–12 h after onset of estrus. The bio-stimulatory effect of the teaser bull allows for a general increase in reproductive efficiency in a herd by improving the percentage of animals cycling, and by improving the pregnancy rate from 19 to 43%. Although buffalo are polyestrous, fertility is reduced during the off-breeding season (spring and summer) and during the period of increasing daylight and summer heat.

Preventive Health Measures at Pig Farm (Sty): A Half Success!

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Successful swine production requires the application of health-conserving, disease preventing, and parasite-controlling measures to the breeding, feeding, and managing of the herd. Pigs are the cleanest animal. However, in many cases they are kept in old, crowded areas. Such conditions favor the attack by the common diseases and parasites of swine. (Agricultural Instructional Materials ADAP 96-4 - Swine Management Manual). Diseases cause loss of production and frequently a loss of body condition. In diseased animals, growth takes longer time than healthy stock. They are prone to almost all types of infection due to poor immunity and disease resistance capacity (N.S.R.Sastry and C.K.Thomas, 2010).Minimizing or preventing disease entry and spread on farms is the goal of an effective Biological Risk Management plan. To implement this, there are several general management practices that every farm could implement with minimal cost. If done properly, they can help prevent and control a variety of diseases. Simple and basic considerations include knowing what is in the area of your farm perimeter (e.g. farms, visitors, neighboring livestock and wildlife), people, vehicles, animal health protocols, recognizing and dealing with sick animals, isolation/quarantine, supply handling and cleaning and disinfection.

Therefore, better and concrete implementation of preventive measures in the farm like good animal health programme etc. can lead to better running of sty in a profitable manner.Hence,in the below paragraphs, preventive measures are discussed in details.

SWINE HEALTH GUIDELINES

1. Sow : Clean farrowing quarters thoroughly a few days before parturition. Scrape loose dirt and dust from the ceiling and walls. Remove litter, filth, and manure from the floor. Disinfect the floors and walls with white wash. Disinfect watering and feeding equipment chemically or with scalding hot water. Before moving the sows into the farrowing quarters, scrub them with soap and warm water, especially around the udder and belly. This removes adhering parasite eggs (especially round worm) and disease germs.

2. Piglets: Until the newborn pigs are moved to clean ground, place a little uncontaminated iron supplementation in the corner of the pen daily. This precaution will help prevent anemia. Commercially available iron supplements can be given as injections in areas that have access to these products. When the pigs are ten days to two weeks old, haul the sow and litter to a clean pasture.(Because of the hazard of worm contamination, haul, don't drive, the animals to the pasture.) Vaccinate all pigs for cholera. When swine erysipelas exists, the baby pigs should receive the serum treatment at a few days of age and again just before weaning time. In highly infected areas where death losses are excessive, vaccination may be used to good effect. In valuable purebred herds, a brucellosis herd test should be made annually and more frequently if the disease is encountered. Other management practices that should be considered are teeth clipping, tail docking, ear notching, and castration.

3. Housing: Satisfactory housing is essential because hogs are more sensitive to extremes of heat and cold than other farm animals. Divide the hogs into small groups based upon size, age, and sex. Young hogs do not thrive when forced to pile up in sleeping quarters or when crowded away from the feed trough by larger animals.

4. Sanitation: Housing should be dry, easy to clean, sanitary, and well ventilated. Keep the bedding clean, fresh, and dry at all times. Disinfect the floors and walls at frequent intervals. When weather conditions permit, open housing to direct sunlight. Avoid muddy lots and wallows. Keep the fence rows clean and free from weeds. Do not allow manure, food remains, and other litter to accumulate in the lots. Spread pig manure onto a field where pigs do not run. Destroy all rats and bum or deeply bury all carcasses of hogs that die on the farm . If parasites or disease are encountered, isolate the infected animals, consult veterinarian, and apply the recommended medicine or insecticide.

5. Feeding and watering areas: Concrete feeding floor especially desirable during the rainy season.A concrete floor is a necessity for successful garbage feeding and it should be cleaned daily. Provide clean fresh water in a suitable trough or drinking fountain. Feed a balanced ration at all times. To prevent contamination by excreta, design the feed and water facilities so the pigs cannot get their feet or bodies into them. Ring the snout in order to prevent rooting.

6. Breeding: Avoid both overweight and underweight breeding animals. Select breeding stock from disease-free herds. Quarantine all new animals for at least two weeks before introducing them into the herd. Do not permit commercial truckers of stock to drive on the premises unless the truck has been thoroughly disinfected. Force the brood sows and the herd boar to take plenty of exercise. (Source:Agricultural Instructional Materials ADAP 96-4 - Swine Management Manual)

BIOSECURITY MEASURES TO BE FOLLOWED

Good biosecurity helps keep out diseases that are not on farm from entering farm

and those on farm from spreading to other farms, e.g. diseases such as classical swine fever and parvovirus, etc.Good biosecurity reduces the risk of zoonotic diseases, limits the occurrence and spread of diseases and helps to protect neighbors, public health and the countryside.Also, it improves health of pigs, cuts costs of disease treatment, reduces economic losses which ultimately improves farm profitability.

1. Visitors: Care must be taken to ensure that visitors should be provided with protective clothing . If possible, visitors should be limited to the reception/office area unless their visit has something to do with pigs.

2 .Disinfectant foot bath : Place disinfectant foot baths (1 % KmNo4) at the entrance to each building . Ensure that all personnel and visitors disinfect their footwear when entering at any of these points. Change the foot bath every 4 to 5 days or when visibly contaminated. Wheel wash, vehicle sprays and mobile equipment any vehicle entering the site should pass through a disinfectant wheel wash and/or vehicle spray. The wheel wash should be topped-up regularly to avoid dilution or contamination. Mobile equipment brought onto the site from other units must be washed and disinfected before being allowed to enter.

3. Loading bays: Loading bays must be cleaned and disinfected after each use.

4. Paths and roadways: Keep farm access routes and roadways clear of dung and refuse and regularly spray with an appropriate disinfectant, to reduce the potential spread of infection on the farm.

5. Personal hygiene*:* Farm workers should be provided with protective clothing
and should change when moving to another house where possible. Provide basins for both hands and feet (gumboots). Dirty or unwashed hands transfer infection. All visitors to the site must go through the foot bath and wash their hands before entering the houses. All staff members must wash their hands before starting work, after breaks and when changing activities.

6. Water lines and drinkers*:* Continuous disinfection is important to maintain water quality during the production cycle. Drinking water can be a potent source and spread of infection and can lead to reduced performance. Header tanks and pipelines need to be cleaned regularly and disinfected with a non-tainting disinfectant (Bleaching powder, alum etc).

7. Rodent control: Rats and mice can be responsible for the spread of a number of serious diseases, such as swine dysentery, salmonella and leptospirosis infections.
Ensure that feed spillages are removed as quickly as possible and that houses are made secure from vermin. Implement effective rodent control measures. Store feed in rodent safe containers/places.

8. Record keeping: Record keeping helps with the indication of the economic progress. Helps to monitor health, growth and management practices. The simpler the records are the better. Manual records are often easier and more basic than computerized records. (Source:

Department of Agriculture, Forestry and fisheries, Republic of South Africa – Swine Biosecurity Measures, 2013)

ISOLATION AND QUARANTINE:

Isolation of sick animals is necessary to minimize disease exposure of others in sty and quarantine is required to prevent exposure to new or returning animals. Equipment (feed, treatment, restraint) should not be shared between isolation and quarantine animals. If equipment must be shared, wash in warm water and soap to remove visible contamination, rinse, disinfect and rinse before removing from one location and moving it to another. Immediately isolate sick animals from the herd to minimize disease spread. Prevent direct contact between isolated animals and others. Prevent sharing ventilation, feed/water and equipment to minimize the risk of disease spread. Use separate facilities, equipment and staff to handle isolated livestock. If this is not possible, at a minimum, handle or visit the isolated animals last. Clean and disinfect all equipment, clothing, boots, etc. that come into contact with ill and isolated animals.

Any animals that have recently been purchased or returned to the farm should be quarantined. New or returning animals (e.g., shows, breeding) can be infected with a disease without showing signs right away. Quarantine allows time for a disease to develop in the animal, without exposing farm to the disease agent. Do not allow new additions and animals returning to share water, feed or facilities with your other animals. Ideally animals should be quarantined at a separate location (premises). Time spent in isolation and quarantine varies depending on the disease risk. It is a good risk management plan to test for key diseases before taking animals out of isolation or quarantine to make sure they are not carrying diseases that could be introduced into farm. Test breeding swine for brucellosis, leptospirosis, and pseudorabies. Obtain a health certificate showing all tests and vaccinations at the time of purchase. Make sure the swine are properly identified and delivered in a clean disinfected truck. Isolate newly purchased swine for 30-60 days and keep them at least 300 feet from other swine. Retest for disease before adding them to the herd. Never bring newly purchased sows or boars into a farrowing house or expose baby pigs to new animals. Keep visitors out of hog lots and swine facilities. Keep rubber boots, disinfectants, and a change of clothing available for those who must enter the premises.

Wildlife and other Animals: Prevent contact with free roaming animals (e.g. wildlife, feral swine, cats, dogs, etc.). Control of wildlife may be difficult, but should be attempted. Keep farm access routes, parking areas, yards and storage areas clean and tidy to avoid attraction of birds or rodents. Minimize bird contact and nesting in your operation. Birds are disease carriers and while it is nearly impossible to eliminate them from animal housing areas, steps should be taken to discourage their nesting and roosting. Maintain a rodent control program. Rodents harbor diseases that can affect pigs and can also readily

contaminate feed. Secure all feed storage areas and clean up spilled feed to minimize access by pests.

Give access to only trained personnel. Training should include proper handling and administration of biological products when to use them. Improper handling and storage can cause contamination which could cause disease. Improper use of vaccines and medicines can make them ineffective and some can even be harmful to the person. Correct antibiotic use helps maintain effectiveness in treating disease. Improper and haphazard use of antibiotics can lead to the development of antibiotic resistance. To be effective, disinfectants (Bleaching powder 30 % ,cresols 2 %, caustic soda 2 %,phenol 1 %,QAC 0.1 % washing soda 4 % etc) need time to kill the microorganisms present.

Vacating the sty

This technique breaks the disease cycle especially when combined with thorough cleaning and disinfecting. . Keep the facility empty for 3 weeks or longer for best results, but even a few days are helpful. Rotate pastures, feeding floors, and farrowing pens to reduce the number of parasite eggs and infectious agents.

DEWORMING

Regular deworming is essential in hot and humid areas. The farm should be kept worm free. The most suitable time of deworming is the early stages of infection when the worm load is less. Strategic treatment is useful and frequently necessary. Piperazine is only of use against the round worm and nodular worm. Broader spectrum anthelmintics such as Thibendazole are necessary for effective treatment of the other parasites. Deworming should be done before vaccination for effective vaccination. Treat the sows for worms and mange before moving them to the farrowing area. Treat boars twice a year for worms and mange and, if needed, trim their tusks.

(Source: Agricultural Instructional Materials ADAP 96-4 - Swine Management Manual)

VACCINATION

A practice of building induced immunity in the animal's body against specific infectious diseases by injecting a live, attenuated or dead bacterium, virus, fungus, and toxins, toxoids or any other metabolites etc. produced by microbes called as vaccination. Injection of vaccine for any particular disease leads to production of antibodies after an interval of 14-21 days, producing active immunity against the disease. Vaccination may be used prophylactic ally in prevention of disease but never a substitute to good sanitation and hygiene on sty. Vaccination can be done by intra-muscular or subcutaneous route.

ELIMINATION OF CARRIERS

Germ carrying animals are known as 'carriers'. Generally, convalescent animals are carriers for a short duration. The carrier state may remain for years and the animal becomes a potential danger to susceptible animals, in many diseases. Carriers of diseases in the sty should be diagnosed and eliminated so that sty may be completely free from diseases.

Table.1 Vaccination schedule of swine

Sr. No	Disease	Age of animals	Time of vaccination
1	Hog cholera	Sows/boars/Gilts (Crystal violet vaccine)	After weaning
2	Swine erysipelas	Sows/boars Gilts (Alum treated vaccine)	After weaning
3	FMD	Sows/boars Gilts (Polyvalent tissue culture vaccine)	6 months of age with booster dose 4 months later
4	Transmissible gastroenteritis (TGE)	Piglets	At 3-7 days of age (On 3rd day iron injection should be given)
5	Porcine parvovirus	Sows/boars	2 wks before breeding
		Gilts	6 months of age or 5 wks before breeding
6	Leptospirosis	Sows/boars	2 wks before breeding
		Gilts	6 months of age or 5 wks before breeding
7	Anthrax	Sows/boars Gilts (Spore vaccine)	Once in a year (Premonsoon vaccination)

(Source: N.S.R.Sastry and C.K.Thomas, 2010)

DISPOSAL OF CARCASSES

Proper disposal of carcasses of animals died of infectious diseases is of prime significance in preventing the spread of diseases. Carcasses should never dispose off by throwing near a stream of flowing water as it leads to infections to points downstream. Also, carcasses died of infectious diseases should not be kept in farm premises as insects, rodents, etc. can reach their and can transmits disease to others. Hence, carcasses should be disposed off immediately by either burning or incineration or burying methods. Have them removed immediately by a licensed rendering company. Bury them at least three feet underground and away from any source of drinking water. Cover them with quicklime before adding fill dirt. Prevent pets and predators from carrying dead animals between farms.

(Source: N.S.R.Sastry and C.K.Thomas, 2010 and Agricultural Instructional Materials ADAP 6-4 - Swine Management Manual).

DISINFECTION

Destruction of pathogenic microbes from a place so that place becomes free from infection is called as disinfection. The common disinfecting agents are sunlight, heat and chemical disinfectants. Sunlight

possesses strong disinfecting properties. Uses of heat by steam, hot water or boiling are the effective methods of disinfection by heat. Chemical disinfection by using bleaching powder 30 % ,cresols 2 %, caustic soda 2 %,phenol 1 %,QAC 0.1 % washing soda 4 %,sodium hypochlorite etc. Germicides for disinfecting a building should work well in the presence of organic matter are compatible with soaps or detergents, harmless to building materials, and relatively non-toxic. High temperatures drive off the active ingredient from disinfectants containing chlorine or iodine. Some disinfectants are affected by the pH balance and hardness of the water. Many cleaners and disinfectants are poisonous, hence to be store in tightly closed containers in a safe, locked area out of reach of children and other unauthorized persons, and away from feed and other supplies. NEVER mix bleach and ammonia, as they form a highly toxic substance when combined. Keep the labels on all containers and observe safety precautions.

(Source: N.S.R.Sastry and C.K.Thomas, 2010 and Agricultural Instructional Materials ADAP 96-4 - Swine Management Manual).

DISEASES IN SWINE

A Diseases associate with farrowing :

- MMA syndrome (Mastitis, Metritis and Agalactia)
- Abortion – Porcine brucellosis

B. Diseases of piglets:

- Early death – Due to crushing by sows due to lack of guard rail.
- Scours - E.coli ; treated by antibiotics
- Transmissible gastroenteritis (TGE) – Acute scour due to virus leads to greenish diarrhea with excessive thirst and vomiting.
- Anemia – An injection of iron or iron pasted on sows teats require preferably within a week to avoid mortalities.
- Genetic diseases – Particularly in boars; defects includes scrotal & umbilical hernias, absence of anus, and splay legs. Defective boar should be checked and replaced with new.

C. Parasites in pigs:

- Roundworm – *Ascaris.suum*
- Lungworm – *Metastrongylus.spp*
- Whipworms – *Trichuris suis*
- Srewworms – Myiasis
- Trichinosis – *Tricinella spiralis*
- Stomach worm – Hystrongylus (Older pigs)
- Nodular worm – Oesophagostomum – causes anemia and scours
- Kidney worm – *Stephanurus dentatus*
- Hog lice – Haematopinus spp
- Ticks and mites.

D. Diseases that affects pigs of all ages:

- Swine fever
- FMD
- Anthrax
- Worms
- Skin Parasites – Sarcoptic mange (most common of the skin conditions)

E. Problems associated with weaning:

- Stress reactions – It should not be done suddenly. Creep feed should be given.
- Salmonellosis – high fever, bloody scour and some deaths .Good sanitation is important

- ❖ Vibrionic scour – poor management ;diarrhea with blood stains
- ❖ Enzootic pneumonia and other respiratory diseases.
- ❖ Swine erysipelas – dullness, fever, anorexia, redness of the skin, and deaths.

F. Conditions associated with management:

- ❖ Heat stroke – Heavy pigs are more susceptible (Large white & landrace breeds) due to inadequate ventilation.
- ❖ Lameness – It is a frequent problem of heavier pigs housed on concrete floors. Rough concrete leads to FMD, arthritis, or bacterial joint infection.
- ❖ Routine use of drugs – Antibiotic resistance increasing

(Source: Agricultural Instructional Materials ADAP 96-4 - Swine Management Manual)

CONCLUSION

Therefore, good animal health programme, purchase of good healthy stock, proper quarantine of newly animals purchased, sound sanitation practices, proper management, balanced nutrition, timely deworming, use of good quality vaccines are the practical and economical ways to avoid losses from diseases. Prevention of disease is better and economical than curing the disease outbreak. It is the magical stick of running the farm in economical and successful manner. Also, following all proper preventive measures in the sty is considered as 50 % success of the farm owner or enterprise. Therefore, it is recommended that every sty farms should strictly follow the above mentioned preventive measures in the farm for its betterment.

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Swine Management Manual - Agricultural Instructional Materials ADAP 96-4

The Importance of Dietary Inclusion of Animal fats in Swine nutrition

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The feed cost is the most important cost in pig production and energy represents the greatest proportion of this cost. Cereal grains forms the major source of energy in the swine feed. The lower availability and increasing price of maize, necessitates an alternative energy source for incorporation in the swine feed. Animal fat (lard, tallow, poultry fat) is a by-product of meat industry and can be included as a source of energy. Due to their high energy value, being approximately 2.25 times that of carbohydrates, the use of fats and oils in diets for pigs is of great importance. The use of fat as an energy source for pigs has been shown to increase digestibility of nutrients, improve growth rate and also reduces dustiness of feeds and increases palatability. Other alternative energy sources include vegetable fat sources (coconut oil, palm oil, palm oil mix, corn oil, rapeseed oil and soybean oil) and marine fat sources (fish oil). Animal fat has largely been used in pig feed although its energy value is generally lower than the energy value of vegetable fat sources or fish oil. In spite of this, the higher content of saturated fatty acids (mainly 16:0 and 18:0) makes animal fat preferred, since high levels of unsaturated fatty acids from vegetable or fish oil may result in reduced product quality.

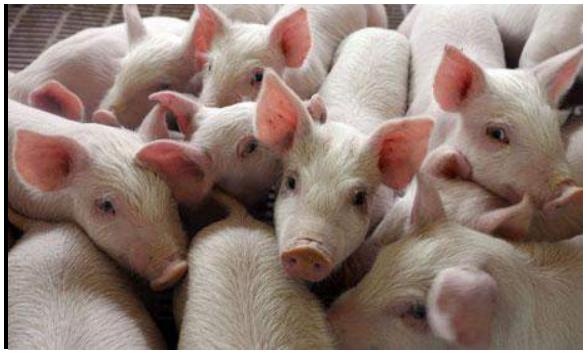
GROWTH PERFORMANCE

Addition of animal fat to the diet has characteristic effect on performance which includes increased growth rate, decreased feed intake and improved feed efficiency. The magnitude of the performance changes is influenced by the stage of production. Because of the increased energy density of fat (relative to protein or carbohydrate) and the ability of animals to regulate intake based on the energy content of feed, it is necessary to increase protein content to ensure adequate amino acid intake when fat is added. The magnitude of the reduction in intake was greater than that of gain and thus, the gain/feed ratio was also significantly improved in pigs fed supplemental fat (Tokcach *et al*., 1995: Cromwell, 2006). The main effects noted

in growing-finishing pigs are improved gain and efficiency, decreased intake and increased carcass fat (Baudon *et al*., 2003; Apple *et al*., 2004). The decreased intake in older pigs is a more consistent response than in nursery pigs, particularly when the dietary fat level exceeds 3%.

REPRODUCTION

By far the greatest interest in the use of animal fat in swine diets has centered on sow nutrition. Seerley *et al*. (1974) observed that fat addition during late gestation resulted in improved neonatal survival. Foetal energy demands are greatly increased during late gestation and catabolism of maternal reserves occurs if dietary energy supply is insufficient to meet requirements. Animal fats are traditionally introduced into late gestation and lactation diets as a high energy supply to improve neonatal survival and milk yield, and to reduce mobilization of body reserves. Furthermore, the efficiency of using metabolizable energy from lipids is very high, and they have a minimum heat increment compared with other nutrients, thereby reducing summer heat stress.



Increasing the energy intake of sows during the anabolic phase of gestation is likely to increase the amount of fat available for mobilization during late pregnancy, and may result in enhanced sow performance during lactation. Subsequent studies suggested that the effects were more likely accounted by greater energy stores in the pig at birth that resulted in a greater ability to sustain life until adequate nutrition was obtained from the sow. A more reproducible response to fat feeding in late gestation and lactation leads to an increase in the level of fat and thus the energy density of both colostrum and milk.

NUTRIENT DIGESTIBILITY

Fat has the effect of slowing passage rate in the digestive tract and this effect is the opposite of what is seen with fiber in the diet. Because passage rate is reduced, the digestibility of other nutrients is improved. This is referred to as the extra-caloric effect of fat. Digestibility of the fat or lipid in sows milk is >90%. Digestibility of fat in starting diets is reduced during the first week post weaning but increase with age and gradually returns to the 90% range by 4-6 weeks post-weaning. In the post weaning, digestibility of shorter-chain saturated or long-chain unsaturated fatty acids is better than that of long-chain saturated fatty acids (Cera *et al*., 1989) and the digestibility increases as double bonds are introduced.

ANIMAL CARCASS FAT

The adipose tissue of pigs reflects the dietary fatty acid composition as fatty acids are absorbed largely unchanged and frequently deposited directly into carcass fat (Madsen *et al*., 1992). Accordingly, the use of unsaturated vegetable oils in pig diets will result in enhanced levels of linoleic acid in pig fat. Body fat synthesis from dietary fat is about 90% efficient whereas body fat synthesis from

carbohydrate is only about 70% efficient as a result of net energy to digestible energy is about 0.85 for fats and oils and 0.75 for carbohydrates. A high dietary level of linoleic acid will produce high linoleic adipose tissue in pigs and the levels can increase from a normal 10-15% linoleic acid in adipose tissue up to 30-40% linoleic acid with a consequent dramatic softening of the carcass fat (Monziols *et al*., 2007).

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Constraints of Goat Breeding In Indian Himalayan Region

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In our country, rise in population, escalating urbanization, income growth and increase in standard of living results leads to increasing demand for meat. In Himalayan region, goat meat is the most preferred and most consumed meat. Because, the religious taboos on beef and pork, lesser utility of sheep for meat, less availability of fish and limited chicken production. The moderate shift in the consumption pattern from vegetarianism to non-vegetarianism is also helping increasing the demand for goat meat. In order, the higher meat demand leads to great opportunities for the goat sector. At the same time environmental and public health issues force the goat producers to adapt adequate production technologies for quality meat production. These are enormous challenges for small size goat producers; which are often lack of scientific knowledge and market opportunities. Hence, our article focuses on various constraints exhibiting in the goat production in the Himalayan region.

Goat breeding strategy in Himalayan region:

Last forty years of goat breeding improvement programmes gives lot of bitter experiences in Himalayan region. Because, due to typical temperate climate the crossbred goats survivability were very low compare to local breeds. So, need to develop a genetic improvement programme for improve the local breeds. It should possess local breed identification, data recording, selection and farmers training for scientific goat farming. In addition, the structure can support other interventions such as facilitating access to inputs and linkages to markets.

Breeding preferences in Himalayan region:

Himalayan region the farmers are having averagely 1 to 2 goats per home. Some of the small holders, without scientific knowledge they prefer non-descriptive elite bucks for breeding programme. But majority of the farmers not interested to prefer bucks for breeding. They didn't know their goats when mated and whether pregnant or not. Because, farmers not monitored their goats during

graze time in forest. Many times, farmers did cross-breeding without adequate knowledge about the consequences of cross-breeding. It is note-worthy that such cross-breeding among indigenous breeds started by goat keepers themselves and the results of which are obviously desirable to them.

Constraints faced by smallholders in goat breeding:

i. Major constraints faced by smallholders are non-availability of good quality breeding bucks.
ii. Especially in areas such as Uttarakhand where the majority of goats keepers are smallholder with one or two goats per family. Such owners cannot afford to maintain breeding bucks.
iii. Does remain absence of offspring for long periods of time due to lack of breeding bucks near them. Resulting severe reduction in their income from the does.
iv. Some goat-keepers having larger flocks. They sale fast-growing male kids to butchers for their urgent need of money. Farmers don't know those fast growing kids were having genetically superior traits. Often the slow-growing stunted kids that get left behind end up in breeding with the does.
v. Some farmers have a habit of keeping breeding bucks, does and male kids together in the same flock. Results accidental mating of young doe's results in pregnancy leads to abort or their kids are stillborn or die soon after birth. This stress on the doe so debilitates it that it can never grow into a successful breeding animal.
vi. This phenomenon is not noticed in sheep flocks who keep rams and ewes together. Because ewes attain sexual maturity and exhibit oestrus at a slightly older age than does.
vii. The main constraint in the expansion of flocks with the small holders are lack in resources such as space, funds for investment and graze land especially during winter, as well as the lack of labour to look after additional animals.
viii. Inadequate access to health care, particularly vaccination, is another major constraint in goat rearing.
ix. The perception that goats are detrimental (browsing hobbit leads to destroying forest) to the environment has also had a negative impact on goat rearing and there are limited credit opportunities and loan schemes for goat farmers.

CONCLUSION

Removing the various constraints faced by goat keeper will pave a way for successful systematic breeding programme in Northern-India. This results in development of new breeds with higher economic traits including the easy availability of guaranteed good quality animals. Many of the breeds that we have today have probably evolved from such cross-breeding by communities themselves. Hence, Initiatives should be taken to study and compile the existing data from field to improve the chances of success in more systematic genetic improvement programmes.