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Tear-less Onion:

via Gene Silencing Lachrymatory Factor Synthase (LFS)

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Onion is now the world's second most grown vegetable after tomato (FAOSTAT). The market for low-pungency onions is escalating in the United States and the United Kingdom. The use of the low-pungency onions now accounts for 15%-25% of total onion consumption in the United States. Pungency has been correlated with production of lachrymatory factor (LF) upon cutting or chopping. High pungency and LF induced tearing generally provide a detrimental experience for consumers who seem to prefer low-pungency types. Onions produce the irritating volatile sulphur compound known as syn-propanethial-S-oxide (allyl sulphate) and released, when ruptured onion's cells exposed to air. It stimulates the eye'slachrymal glands so they release tears. Scientists used to culpability the enzyme allinase for the instability of substances in a cut onion. Current studies from Japan, however, proved that lachrymatory-factor synthase; (a previously undiscovered enzyme) is the culprit

1. Lachrymatory-factor synthase is released into the air when we cut an onion.
2. The synthase enzyme converts the sulfoxides (amino acids) of the onion into sulfenic acid.
3. The unstable sulfenic acid rearranges itself into syn-ropanethial-S-oxide.
4. Syn-propanethial-S-oxide gets into the air and comes in contact with our eyes. The lachrymal gland become irritated and produces the tears.

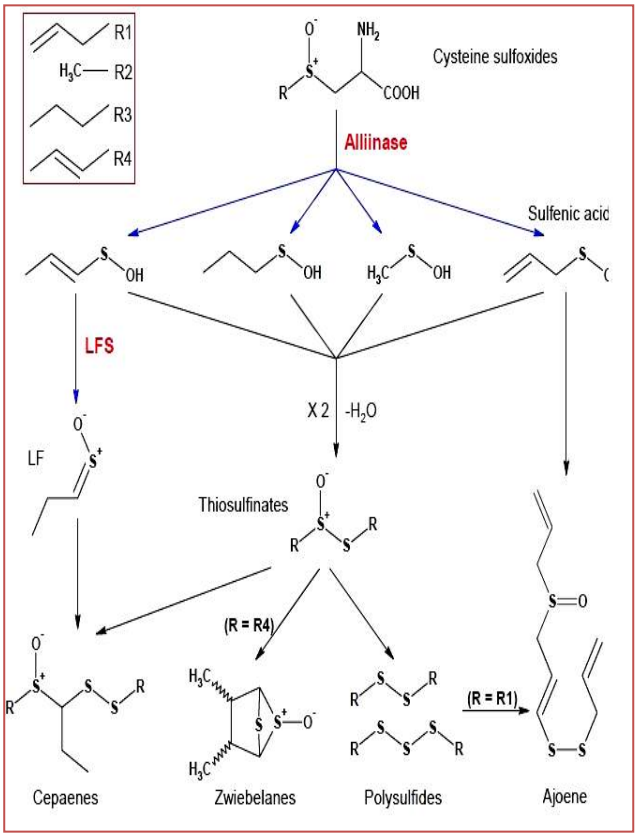

Figure 1.Major breakdown pathway of S-alk(en)yl-L-cysteine sulfoxides (ACSOs) in Allium species. (Source:Takahiro K., 2008)

DISCOVERY OF LFS

People experiences the irritating tearing and burning feeling of LF when cutting or chopping onion bulbs. It is the LF that

critically distinguishes onion from garlic. Very recently, the mechanism of producing LF has been revised. Previous studies suggested (Block *et al*., 1979) that in chopped onion 1-PRENCSO, the major cysteine sulfoxide in onion, is cleaved by allinase to produce 1-propenyl sulfenic acid, and that the sulfenic acid is subsequently converted into LF and thiosulfinates spontaneously *via* different pathways because the sulfenic acid is very unstable and has never been isolated.However, Imai *et al*.(2002), when investigating discoloration in a mixture of onion and garlic, discovered that the reaction converting 1-propenyl sulfenic acid into LF is catalyzed by a novel enzyme, lachrymatory factor synthase (LFS) encoded by *lfs*gene (GenBank accession number AB089203). The *lfs*gene has no intron region and a predicted gene product of 169 amino acids. The LFS protein acts specifically upon 1-propeny sulfenic acid and contains no defined structural domain. Interestingly, there is no LFS activity in garlic.

HEALTH BENEFITS OF TEARLESS ONION

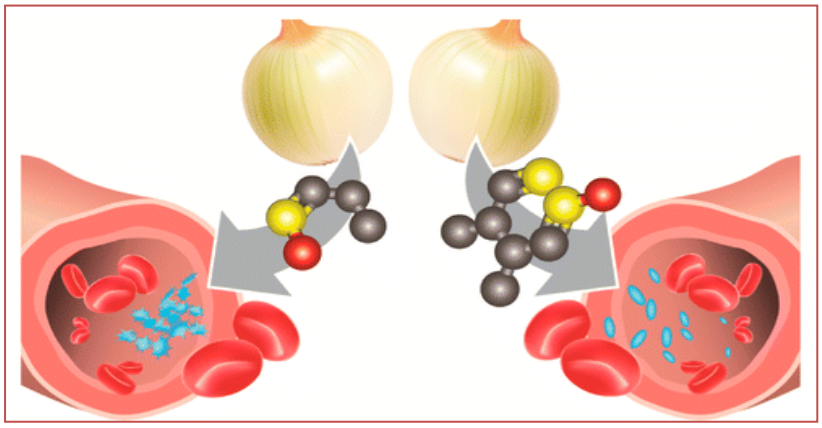

Figure2.Collagen-induced in-vitro platelet aggregation in tearless and normal onion (Source: Susan et al., 2013)

1. The collagen-induced *in-vitro* platelet aggregation is significantly reduced with tearless onion extract over normal onion extract. A preliminary rat feeding trial indicated that the tearless onions may also play a key role in reducing weight gain.
2. Increased beneficial health effects on cardiovascular, anti-inflammatory and anti-carcinogenic effects that are associated with thiosulfinates and disulfides.

Strategies for silencing LFS enzyme activity

There are three approaches to silence LFS enzyme activity:

1. *lfs*gene knockout by homologous recombination-dependent gene targeting ormutagenesis.
2. *lfs*gene transcript degradation by RNA interference.
3. LFS enzyme inhibition by competition with an inactive LFS mutant protein.

GENE SILENCING

RNAi works by specifically degrading targeted transcript sequences. The gene silencing system is triggered in the cell by the detection of double-stranded RNA (dsRNA) that is complementary to the target sequence. Fire *et al*. (1998) discovered that the dsRNA couldinduce gene silencing in *Caenorhabditis elegans*. Since then, other components of the RNAi system have been clarified. The dsRNA is cleaved by the RNaseIII-type multidomain enzyme Dicer to give small

dsRNA of 21-26-nucleotide named small interfering RNAs (siRNAs) which have 2-nt overhangs at their 3' ends and phosphate groups at their 5' ends. siRNAs are subsequently incorporated into a multi-subunit RNA-induced silencing complex (RISC) to form a RNA-protein complex. The antisense-strand-containing RISC binds to the target mRNA and suppresses gene expression by degrading the target sequence (Figure 3) (Waterhouse and Helliwell, 2003).

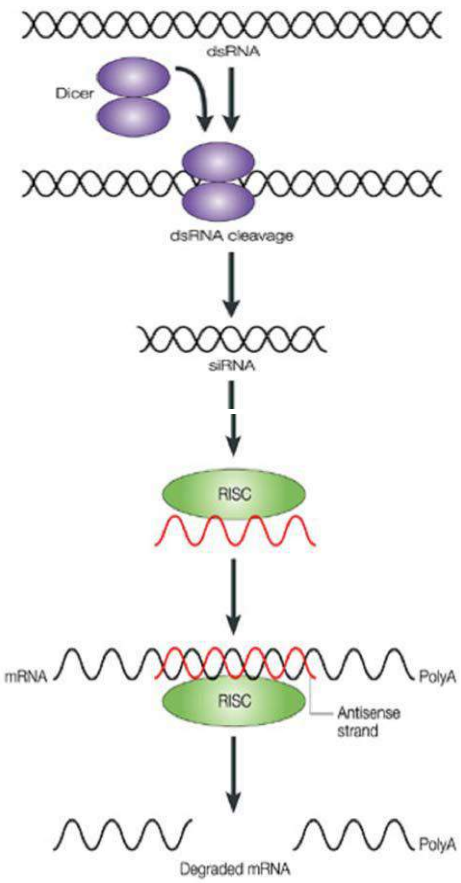

Figure 3. The current model of RNAi in plants (adapted from Waterhouse and Helliwell, 2003).

KEY PROBLEM WITH TEARLESS ONION

1. Current low pungency onions have poor storage characteristics thus there is an obvious niche for a long storage low-pungency type onions.
2. Potentially losing many of the characteristic flavour notes and health benefits related to these volatiles.
3. Field tests of tearless onions shows more prone to diseases and pest.

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Calf Rearing:
Individual and Group Housing System

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Abstract

"Proper rearing of calves improves good behaviour and growth which leads to better performance in the future."Recently, many worldwide organizations have focused great emphasis and concern on the impact of animal housing in animal well-being. It is important for all producers to enhance the well-being and quality of life of dairy calves. Providing adequate nutrition, health care, animal husbandry, and management are essential. Ensuring the proper environment for each calf is equally as important. The optimal environment for housing newborn and growing dairy calves should provide physical, psychological, and behavioural comfort. The type of housing affects all these variables directly or indirectly. All variables should be considered when developing a management plan and therefore, a suitable housing system needs to be found that is most beneficial to the well-being and performance of the animal during making management plan for rearing of calves.

BASIC HOUSING REQUIREMENTS

Numerous calf housing options are available, each havingadvantages and disadvantages but for goodhousing, requirements are basically the same. Good calf housing facilities should:

- Be in a completely separate area, away from the main dairy housing barn
- Have pens that should be clean, dry, free of draught, well ventilated and amply lighted
- Have optimum temperature of 50 to 60º F and a relative humidity of 65 to 75%
- Provide convenient storage for feed, bedding and supplies
- Be constructed of durable and easily cleaned materials especially in the area where the youngest calves are housed
- Free of projections that may cause injury

Gold Standards for calves from 24 hours of life to 60 days include these goals:

1. Mortality: < 5 percent
2. Scours requiring intervention lasting at least 24 hours: < 25 percent
3. Pneumonia requiring treatment:< 10 percent
4. Growth: Double birth weight by 60 days

When selecting a calf housing system, there is need to consider climate, budget and labour constraints and individual preferences. Remember, even the very best facilities will not succeed without proper management. Some advantages

and disadvantages of individual and group housing system are being described below that can be considered while selecting any type of housing system for calves.

INDIVIDUAL HOUSING SYSTEM

Advantages:

- Offer good access potential for the caretaker
- Close monitoring of each calf and observation of individual calf behaviour and health
- Allow separation of a calf from other stock and reduce spread of disease
- Provide good ventilation
- Permit ease of cleaning and sanitation
- Permit less exposure to faecal material
- Least risk of diarrhoea and respiratory disease
- Allow easier record keeping
- Have a well defined eating and resting space
- Less cross-suckling behaviour

Disadvantages:

- Little opportunity for contact between calves
- Limits the extent to which the calf can behave naturally
- Growth check at weaning
- More labour intensive
- Labour intensive feeding

Recommendations for dealing with potential problems:

- ✓ Always provide milk via a teat to satisfy the motivation to suck, do not use buckets
- ✓ Provide calves with an opportunity to exercise
- ✓ Engage in normal social behaviour for some time each day
- ✓ Milk volumes should be adjusted sufficiently, particular in winter months
- ✓ Position houses to minimize environmental impacts

GROUP HOUSING SYSTEM

Advantages:

- Allows early social interactions to develop skills needed for group living through play behaviour, which is important for the development of normal social responses later in life
- Provide improved access to space, allowing for more vigorous activity and play
- Easier access for mechanized cleaning
- Less labour intensive, easier management, suited to group feeding systems
- Reduces the labour associated with cleaning calf pens and calf feeding
- Less fear of other calves, novel environments

Disadvantages:

- Harder to monitor individuals
- More disease risk due to increased contact between calves
- More attention on hygiene needed to control disease
- Competition between calves
- Uneven growth rates
- More chances of developing cross-suckling behaviour.

Size of the Group Matters

Studies indicated that calves housed in large group pens had a higher risk for respiratory disease compared to calves in individual housing or small group pens. Calves housed in group pens fare better in smaller groups of 6 to 9 animals compared to 12 to 18 per group. Respiratory disease incidence was lowest in calves housed individually, intermediate in those housed in small group pens (with 3 to 8 calves), and greatest in calves housed in larger group pens (6 to 30 calves with automated feeders). A conclusion from this is that if pre-weaned calves are going to be housed in group pens, the numbers of calves per group needs to be considered.

Recommendations for dealing with potential problems:

- ✓ Incidence of disease is reduced if groups are small and also record highest gains
- ✓ Cleanliness, adequate ventilation and feeding management are considered more important than housing type for disease prevention
- ✓ It is important that calves feed using a teat (nipple bucket or bottle) rather than a bucket and are allowed to suck for an adequate time after their meal to eliminate problems with cross sucking
- ✓ Too many calves for the number of teats increases social competition and reduces intake, so keep group size small

CONCLUSION

Each type of housing system has some merits and demerits in their own way. For a calf in his whole life with any single type of housing systemdoes not seems to be perfect in all; respect of growth, health and welfare of calves. It is concluded that individual housing can be more beneficial for early life (up to 6-8 week) that provide opportunity for accurate feeding, observation and good health whereas, group housing system with small group size and proper hygienic maintenance can be a good way for better performance and behaviour during rest of life.

Repeat Breeding:
Burning Issue Amongst Farmers

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As per society of theriogenology a cow is called as repeat breeder when it has failed to conceive even after three or more number of services, has normal estrus cycle length, no abnormality in the vaginal discharge, no palpable abnormality in the reproductive tract, has calved at least once before and less than ten year of age. Repeat breeding is one the most import infertility problem faced by field veterinarians.

In herds of normal fertility, where conception rates are commonly at 50-55%, about 9-12% of the cows are expected to be repeat breeders. As the conception rate decreases, the number of cows requiring additional services increases. As a result, repeat breeding rapidly becomes a significant problem.

Causes: There are two major causes for repeat breeding.

A) Failure of fertilization

- Wrong time insemination
- Inadequate estrous detection
- Poor semen quality
- Impared sperm transport
- Ovulatory defects – Anovulation & delayed ovulation

B) Early Embryonic mortality

- Progesterone deficiency
- Subclinical infection
- Oviductalblockadge

Diagnosis

A very comprehensive analysis of the entire reproductive program is

necessary to effectively diagnose the complete cause of a repeat breeding problem.

- ✓ Reproductive history
- ✓ General Clinical examination
- ✓ Examine for the normal structure of the reproductive organs, nature of discharge
- ✓ Tubal patency test by PSP dye.
- ✓ Microbial culture of vaginal discharge

MANAGEMENT

The treatment program for repeat breeding will depend on the underlying cause or causes. It is beyond the scope of this discussion to outline specific treatments for all causes of repeat breeding.

- ✓ Bring the animal into positive nutritive balance
- ✓ Use good quality semen having more than 50 per cent progressive forward motility. Inseminate the cow at right time of the estrum.
- ✓ Do AI twice at 12 to 24 hour interval. Follow proper AI technique.
- ✓ After AI, Clitoral massage or 100 micro grams of GnRH or 1500 IU of luteinizing hormone may be administered to stimulate ovulation.

In summary, a comprehensive, ongoing reproductive management program, involving a team effort by the producer, inseminator and veterinarian, is the key to success in diagnosing, treating and preventing the problem of repeat breeding. Treatment or handling of the problem at present is essentially based on the experience, skill, knowledge and diagnostic procedures employed by the veterinarian to arrive at the cause and contributing causes of the disease.

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Role of Nutrition on Reproductive Performance of Dairy Cows During Transition Period

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An important prerequisite for the sustainability of a dairy production system is that cows must have efficient reproductive performance which is essential for production of milk as well as replacement animals. Reproductive disorders and associated infertility (transient) among dairy animals pose serious economic loss to farmers in terms of low returns and veterinary expenses. Due to impaired reproduction ability, the calving to conception (days open) period is prolonged leading to extended calving interval, which jeopardize the aim of obtaining a calf per cow per year. Maximizing reproductive efficiency requires the matching of genotypes to the production environment, together with appropriate husbandry practices, in order to ensure that days open are short and conception rates are high (Sheldon, 2004). Inadequate or excessive energy, protein, or specific amino acids can have effects at multiple stages of the reproductive process

EFFECTS OF DRY PERIOD LENGTH

One extreme way in altering energy balance during the transition period is to eliminate the dry period. A positive effect of dry period elimination on energy balance, return to estrous cyclicity, and fertility was noticed by Grummer and co workers (2010). When the dry period was eliminated, negative energy balance during the early postpartum period was effectively eliminated (Rastani et al., 2005). Time to first ovulation was reduced when comparing cows that had a 56 day dry period (31.9 + 4.4 d) with cows with a 28 d dry period (23.8 + 3.4 d) and cows with no dry period (13.2 + 1.2 d) (Gumen et al., 2005). The pregnancies per artificial insemination (P/AI) were increased in cows with no dry period (55%) compared with cows with a 56 day dry period (20%) (Gumen et al., 2005). Thus, changes in dry period management can reduce/eliminate negative energy balance during the early postpartum period and increase P/AI .

EFFECTS OF CHANGES IN BODY CONDITION

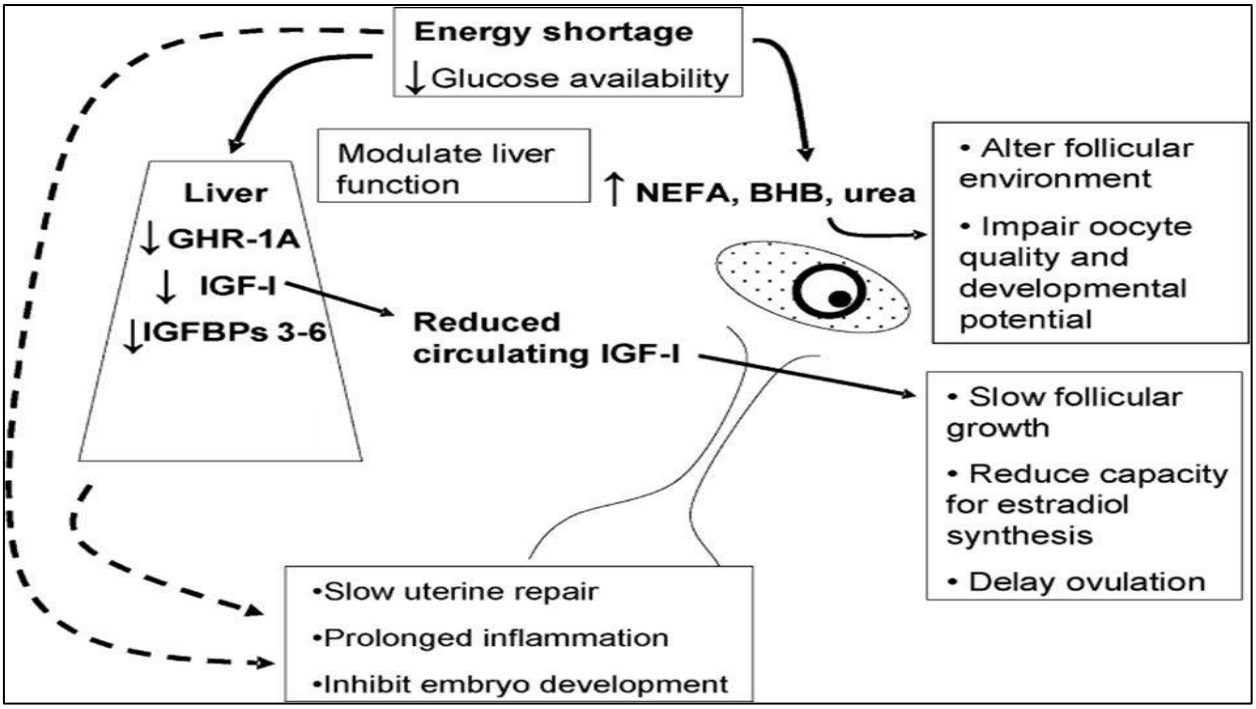

Figure 1: Negative Energy balance affecting reproduction (adapted from Wiltbank, 2015)

Negative energy balance (Fig 1) decreases dominant follicle growth and estradiol (E2) production probably related to the decrease in luteinizing hormone (LH) pulses as well as the decrease in circulating insulin and IGF-1 (Butler, 2005).The magnitude of body condition score (BCS) loss after calving can increase in the percentage of cows that are not cycling at the end of the voluntary waiting period (Gumen et al., 2003). An increase in percentage of anovular cows will lower reproductive efficiency in programs using detection of estrus or synchronized ovulation and timed artificial insemination (TAI) (Santos et al., 2009). Cows with lower BCS near the time of AI have decreased fertility (Moreira et al., 2000) and this may be related to increased anovulation as BCS decreases (Santos et al., 2009).

EFFECTS OF HIGH ENERGY DIETS ON FERTILITY

Increases in feed intake or increased dietary NFC have been found to alter insulin (Adamiak et al., 2005) and progesterone (P4) concentrations (Sangsritavong et al., 2002). Superestimulated beef heifers that were fed a high energy diet ad libitum (excessive energy) compared to 81% of ad libitum intake had reduced number of CL, reduced number of recovered structures, and dramatically reduced yield of transferrable embryos (Yaakub et al., 1999). Thus, excessive energy consumption can alter embryo development, although the mechanism(s) for these effects and whether the effects are on the oocyte or directly on the early embryo are not yet fully described.

EFFECTS OF SUPPLEMENTATION OF SPECIFIC AMINO ACIDS ON FERTILITY

Methionine, Histidine, and Lysine are the amino acids with the greatest increase in concentrations in the uterine lumen during embryo elongation (>10-fold increase on average (Groebner et al., 2011). Arginine is another amino acid

that has been studied extensively in relation to reproduction (Wu et al., 2013) and it is also highly concentrated in the pregnant uterus.The increase in specific amino acids in the uterus near the time of embryo elongation appears to be due to an induction of specific amino acid transporters in the uterine endometrial cells (Gao et al., 2009). The induction of these amino acid transporters is most likely induced by the protein interferon-tau that is secreted by the elongating conceptus (tissues that will generate the embryo and placenta).Disturbances in the temporal relationship between uterine blood flow, induction of uterine amino acid transport, uterine amino acid concentrations, embryonic growth, embryonic interferon-tau production, and rescue/regression of the corpus luteum may reduce fertility and increase pregnancy losses. Excess or deficiency of proteins in diet also affect reproductive efficiency in animals.

EFFECT OF VITAMINS AND MINERALS ON REPRODUCTION

- Zinc has a number of roles in the immune system (superoxide dismutase and metallothionein), Campbell and Miller (1998) speculated that Zn decreases oxidative stress impacting the uterine environment and therefore reproductive measures.
- Weiss et al. (2010) suggested Fe available in the unsupplemented diet was sufficient to meet requirements and therefore a limited response to feeding additional Fe would be expected.
- Scaletti et al. (2003) fed diets supplemented at 20 mg/kg of Cu in diet starting at 60 days prior to calving. Upon challenging these heifers with *Esherichia coli* in one quarter of the udder at 34 days in milk, they found feeding the additional Cu decreased clinical scores 24 h post-infusion (3.2 vs. 4.1) and peak rectal temperature (40.0 vs. 40.8°C). An optimal Cu supplementation level for mastitis resistance has not been established. Mn through superoxide dismutase (antioxidant role) may have a role in mastitis prevention (Tomlinson *et al*., 2008) and reduction of mastitis will improve the overall wellbeing of cow and reproductive efficiency also.
- Spears and Weiss (2008) suggested that supplementing Se-deficient dairy cow diets with Se pre-partum can decrease the incidence of retained placenta and decrease the incidence and severity of mastitis.
- β-carotene serve as lipid soluble antioxidant. Michal *et al.* (1994) reported supplementation of either β-carotene (600mg/day or Vit A (120000 IU/day) significantly reduced incidence of retained placenta compared to control cows.
- The Ca: P ratio, alteration may affect smooth muscle contraction resulting in delayed uterine involution, increased incidence of dystocia, retention of placenta and prolapse of uterus (Sathis Kumar, 2003)
- Combined supplementation of Vit. E and Selenium given a few weeks

before calving either by injection or orally can significantly reduce the incidence of retained placenta in cattle (Hemingway, 2003).

CONCLUSIONS

Nutrition along with good management practices help in improving the reproductive efficiency of dairy animals. Providing adequate energy to maintain BCS postpartum helps in improving reproductive efficiency. Adequate balance of energy, protein, minerals and vitamins must be maintained to achieve higher reproductive efficiency.

Care and Management of Young Calves

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Good dairy herds are raised rather than purchased and as the future productive units of a dairy herd, calves represent a substantial financial investment which needs to be protected by managing and feeding. So that they grow economically and at an optimal rate in order to mature earlier. In the first part of life, calf stomach functions as a simple stomach as in monogastric animals. At birth first three components of the stomach as rumen, reticulum and omasum are undeveloped and do not aid in digesting feeds for the very young calf. When the calf starts to eat calf starter (mixture of grains, protein source, minerals and vitamins) and to drink water, the rumen starts to develop. So proper & timely management and care should be given. Care and feeding of calves truly begin before they are born (two months prior to calving). Pregnant animal should be fed a diet that is balanced to meet their nutrient needs and support the growth of the foetus.

- If a heifer or cow is underfed energy and/or protein, the foetus will still grow to the same size as if she was fed properly, but she will sacrifice her own body reserves or stores to support the growth of the foetus inside her. But these will not be available to support milk production after calving. Thus it will result in lower performance of the cow or heifer after calving.
- Adequate minerals and vitamins are important to the pregnant animal and the calf developing inside her. They are also necessary for the dam to minimize health problems around freshening time such as preventing retention of placenta and to improve the immune system so that the cow can fight off a disease challenge such as mastitis infection just before or after calving.
- Mature cows and heifers should be vaccinated properly and according to vaccination plan.

CARE OF THE CALF AT BIRTH

As calving time approaches, the cow due to calve needs to be watched closely for any complications. Calving should be in a clean, dry and well-bedded pen. Pens should be square and providing 150 to

200 square feet of space having good lighting and ventilation.

- Immediately after birth any membrane or mucus around the nostrils should be removed to facilitate normal breathing using a clean dry cloth. The new-born calf should begin to breathe shortly after the umbilical cord breaks.
- If the calf does not start breathing artificial respiration should be given. This can be done by pressing and relaxing alternatively the chest wall or young-one is lifted by using hind legs with the head in down word direction and swing it; due care should be taken that young one is not slipped during this procedure.
- Shortly after birth, the navel cord of the calf is tied 2.5 cm away from its body and cut about one centimetre below the ligature. The navel cord should be dipped (not sprayed) with a 7% tincture of iodine solution (Do not use teat dip or weaker iodine solutions). Apply antiseptics to the stump for 2-3 days.
- Also any membrane or mucous adhering to the mouth, eyes and ears of the new-born should be removed. Do not pound on the calf's chest or lift it by the rear legs un-necessarily since this can do more harm than good. Birth weight of calf should be recorded.
- The cow should be allowed to lick the calf after delivery. Licking can be induced by sprinkling of a small amount of common salt on calves. In cold weather or if the cow does not lick the calf, the calf should be dried with clean cloths. This practice not only dries the calf but stimulates the calf's blood circulation.
- A normal calf gets up within half an hour and assistance to weaker calf should be given. Feeding of colostrum within the first hour of life is essential for calf to increase the immunity in the body of new-born.

EARLY COLOSTRUM INTAKE

Colostrum is secreted by the mammary gland shortly before and after calving. Calves are born with less immunity acquire their resistance and immunity for disease from their dam through timely and adequate intakes of high-quality colostrum. Calves those do not receive adequate amount of quality colostrum early in life are more susceptible to diseases. Colostrum feeding should be continued for first four days of life. Normally a calf requires 3-4 litres of colostrum daily in three equal feeds.

- In the first few hours after birth the permeability of intestinal mucous membrane for large globulin molecules are high. The amount of antibodies absorbed is related to the timing of colostrum feeding after birth. Within six hours after birth ability of the gut to absorb antibodies decreases by one-third. By 24 hours the gut can absorb only 11% of what it originally could have absorbed at birth. Also at 24 hours of age digestive enzymes break down and digest all of the antibodies.

- Colostrum provides a calf with its primary source of nutrients. True colostrum contains twice as much dry matter and total solids, two to three times as many minerals and five times as much protein as whole milk. Colostrum should be very thick and creamy. The quality of colostrum can be determined using a colostrometer.
- Colostrum also contains various hormones and growth factors that are necessary for growth and development of the digestive tract. Colostrum is lower in lactose, thus decreasing the incidence of diarrhoea.
- Before milking the cow its teats should be cleaned. Calves that do not readily consume their colostrum can be fed using an oesophageal feeder.
- Never fed New-born calves colostrum/milk that is thin, watery, bloody, mastitis, obtained from quarters showing signs of severe mastitis, cows with an elevated temperature, cows that are off-feed, cows found positive for Johne's disease (JD) and from cows treated shortly with antibiotics.

CALF HOUSING

Calves should be housed individually in facilities which are draft -free but provide good ventilation. One way to house calves to prevent the spread of disease from one calf to another is to use calf hutches.

- Calf hutches should be located on a surface with adequate drainage and bedded with straw especially in the cooler times of the year.
- During winters, the hutch opening should be placed facing south to get inside maximum sun light.
- In the summer, calf hutches should be shaded to decrease heat stress and to help improve the immune system of calves. After each calf is removed, calf hutches should be cleaned to control the spread of potential diseases.

MILK FEEDING OPTIONS

For the first two weeks of life, calves receive most of their nutrition from milk. From four days of age calves can be fed either whole milk or reconstituted milk replacer. The type of fed is determined by price, availability and convenience.

- Whole milk can be used to feed baby calves. Calves should be fed daily approximately 10% of their body weight. Feeding less milk than this amount results in poor growth due to lack of needed nutrients. Overfeeding and sudden changes in the amount of milk can cause digestive upsets. Overfeeding milk to calves decreases consumption of dry feed or grain, thus prolonging weaning time.
- Calves are generally fed milk twice daily from a nipple bottle or bucket, or they can drink from an open bucket. When milk or reconstituted milk replacer is fed to calves from either a nipple or open bucket, the oesophageal groove closes and milk bypasses the rumen and is shunted from the

oesophagus into the abomasum or true stomach. The groove closes in response to nervous stimulation and is active in calves until about 12 weeks of age.

- Milk replacer powders are oftentimes economical liquid feed for baby calves. Milk replacer powders should be reconstituted with warm water and fed according to directions on the bag.
- During the first three weeks of life, calves should be fed a milk replacer that contains all milk proteins made from dried skim milk or whey products. Milk replacers should contain a minimum of 18 to 22% crude protein, 10 to 22% crude fat, and less than 0.5% crude fibre.
- During winter season and in cold weather calves should be fed a milk replacer containing 20% fat and more milk replacer powder should be fed.

CALF STARTER AND WATER

Calf starter should be fed to calves starting at four days of age. Calf starter should be formulated to include very palatable ingredients and to contain adequate protein, minerals, and vitamins. For the first two weeks of life, calves will just nibble calf starter but this small amount of starter is important in early rumen development. They should be given no more than a 6-ounce coffee cup of starter daily with the refused feed removed daily and fed to older calves.

- Milk is funnelled through the oesophageal groove to the true stomach and not into the rumen. Thus, milk or water added to milk will not provide water for the bacteria to grow in the calf's rumen. Free-choice drinking water must be provided throughout the year separately starting at four days of age. During extremely cold weather, warm water should be offered two or three times daily.
- Free-choice water increases starter intake and weight gain. Depriving calves of drinking water decreased starter intake by 31% and decreased weight gain by 8% over those calves provided water free-choice. Free-choice water enters the rumen and along with high-quality calf starter helps convert a calf from a simple-stomached animal to one with a functional rumen that can utilize forages and grains.
- Intakes of the starter increase the third to fourth weeks of life according to the development of compound stomach. Hay should feed only after rumen start functioning properly (that is in weaned calves are and/or they are eight weeks of age).

CALF DIARRHOEA

Calf diarrhoea can be caused by overfeeding milk or by any bacterial, viral and protozoan infection/s. Farmers should seek help from their local veterinarians to identify the cause and develop a preventative program. This must be give special attention or death may be the outcome.

WEANING CALVES

Some calves can be weaned at four weeks of age whereas others may be up to 10-12 weeks of age. Calves can be weaned from milk either abruptly or gradually over three to seven days. Calves can be weaned from milk when they are eating daily 1.5 to 2 pounds of starter for three days in a row. Thus, calves should not be weaned based on age but rather on the basis of their intake of starter.

FEEDING CALVES SHORTLY AFTER WEANING

After weaning calves from three to four months of age should be grouped in small groups of four to six. Changes in the grain mixture and group housing should be made gradually over a two-week period.

- Calves need to stay in small groups for the first two months after weaning so that they can adjust to group feeding and to minimize competition among them for feed.
- Excellent quality hay should be fed to calves after they are consuming 5 to 6 pounds of grain daily (Jerseys need to consume 4 pounds of grain due to their smaller body size).
- Calves should not be fed grain mixes containing urea or silages or pasture as the sole forage until after they are four months of age because before that compound stomach is not fully functional.
- Grain mixes fed from two to three months of age should contain 18% crude protein (assuming early cut alfalfa/grass hay is containing 18% crude protein)

MANAGEMENT PRACTICES

- At birth, calves should be identified with an ear tag or tattoo or photograph. Records should be kept to identify the birth date and at least the sire and dam of each heifer. Some farmers, besides recording this information in their record-keeping system, print this information on the ear tag itself.
- At birth, calves can be given an oral vaccine to prevent calf diarrhoea. However, preference is to vaccinate the pregnant cow to provide the calf with the needed protection through consumption of the dam's colostrum. Calves should be vaccinated according to vaccination plan made by local vet. for prevalent diseases in that specified area at recommended age.
- Disbudding is done in 3 to 10 days. When the horn button is visible, the calf can be dehorned easily with a gouge or electric dehorner. If caustic paste is used, take special caution to avoid getting paste on other parts of the body. Dehorning in calves under one month of age is less stressful and easier to accomplish.
- Extra teats should be removed with sterile scissors when calves are vaccinated at four to six months. Before removing extra teat, make sure about teat going to be removed. Tincture of iodine is swabbed on the area where the teat was removed, and the area needs to be checked daily for infection and to see that it is healing properly.

Second Generation Alternate Biofuels for Future Sustainable Transport

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Biofuels are any form of energy derived from a plant source. The most common biofuels are ethanol, an alcohol fuel made from fermenting a sugary source material like corn or sugar cane, and biodiesel, a diesel fuel made from vegetable oils and fats rather than crude oil. Biofuels -- fuels made from biological raw materials -- continue to be the focus of intense research, but so far they haven't come close to replacing petroleum and petroleum diesel made from crude oil. Because different fuels have different energy content per gallon, you can't simply compare the price-per-gallon, but instead need to compare the average price-per-unit-of-energy. And in late 2010 in the United States, gasoline cost on average about $2.78 per unit, while ethanol cost about $3.45 for the same amount. However, you'd pay about $2.86 for biodiesel [source: U.S. Department of Energy]. While biofuels may one day become inexpensive fuel sources that are better for the environment than fossil fuels, they also present challenges: The production of some low-cost biofuels may cause unintended environmental damage. Researchers are exploring "next-generation" feedstock such as algae and grasses, but these are still expensive to produce. In the meantime, there are biofuels available that are relatively easy on the wallet and we'll explore five of them here. When the feedstock for biofuels is grown and harvested in a responsible, sustainable way, the benefits of biofuels impact more than the price at the pump. Biofuels have to potential to reduce pollution, reduce global poverty, and convert millions of tons of waste into clean-burning energy.

1 CELLULOSIC ETHANOL

Bioethanol can be produced from ligno-cellulosic feedstocks through the biochemical conversion of the cellulose and hemicellulose components of biomass feedstocks into fermentable sugars . The sugars are then fermented to ethanol, following the same conversion steps as conventional biofuels. Cellulosic ethanol has the potential to perform better in terms of energy balance, GHG emissions and land-use requirements than starch-based biofuels. The first large-scale plants demonstrating this technology are now coming into production.

2 ADVANCED BIODIESEL

Several processes are under development that aim to produce fuels with properties very similar to diesel and kerosene. These fuels will be

blendable with fossil fuels in any proportion, can use the same infrastructure and should be fully compatible with engines in heavy duty vehicles. Advanced biodiesel and bio-kerosene will become increasingly important to reach this roadmap's targets since demand for low-carbon fuels with high energy density is expected to increase significantly in the long term. Advanced biodiesel includes**:**

- **Hydrotreated vegetable oil (HVO)** is produced by hydrogenating vegetable oils or animal fats. The first large-scale plants have been opened in Finland and Singapore, but the process has not yet been fully commercialized. (Bacovsky *et al.,* 2010).
- **Biomass-to-liquids (BtL)** diesel, also referred to as Fischer-Tropsch diesel, is produced by a two-step process in which biomass is converted to a syngas rich in hydrogen and carbon monoxide. After cleaning, the syngas is catalytically converted through Fischer-Tropsch (FT) synthesis into a broad range hydrocarbon liquids, including synthetic diesel and bio-kerosene.

Advanced biodiesel is not widely available at present, but could become fully commercialised in the near future, since a number of producers have pilot and demonstration projects underway (USDOE, 2009).

Other biomass-/sugar-based biofuels

In recent years, several novel biofuel conversion routes have been announced, such as the conversion of sugars into synthetic diesel fuels.

These include:

- The use of a micro-organisms such as yeast, heterotrophic algae or cyanobacteria that turn sugar into alkanes, the basic hydrocarbons for gasoline, diesel and jet fuel.
- The transformation of a variety of water-soluble sugars into hydrogen and chemical intermediates using aqueous phase reforming, and then into alkanes via a catalytic process (Blommel et al., 2008).
- The use of modified yeasts to convert sugars into hydrocarbons that can be hydrogenated to synthetic diesel

So far, none of the above processes has been demonstrated on a commercial scale.

3 BIO-SYNTHETIC GAS

Bio-SG is biomethane derived from biomass via thermal processes. The first demonstration plant producing biomethane thermochemically out of solid biomass started operation in late 2008 in Güssing, Austria, and a plant is planned in Gothenburg, Sweden (DBFZ, 2009).

The deployment of natural gas vehicles (NGV) has started to grow rapidly, particularly during the last decade, reaching shares of 25% and more of the total vehicle fleet in countries including Bangladesh, Armenia and Pakistan (IEA, 2010d). These vehicles can also be run on biomethane derived from anaerobic digestion or gasification of biomass.

4. ALGAE AS BIOFUEL FEEDSTOCK

Algae have been cultivated commercially since the 1950s, mainly for the pharmaceutical industry, but only recently gained attention as a potential source of biomass. Algae promise a potentially high productivity per hectare, could be grown on non-arable land, can utilise a wide variety of water sources

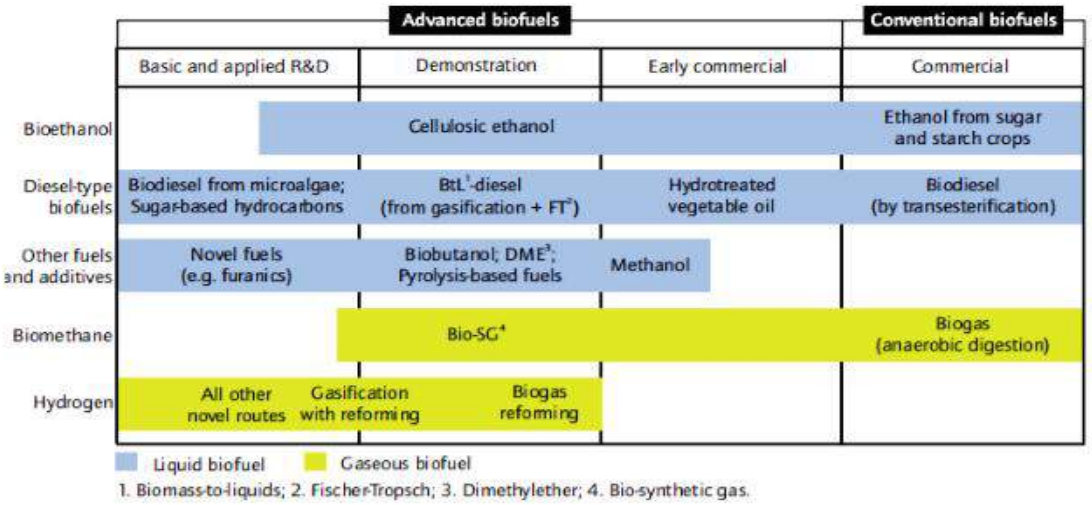

Figure 1: Commercialization status of main biofuel technologies

(fresh, brackish, saline and wastewater), and potentially recycle CO2 and other nutrient waste streams (Darzins et al., 2010). However algae cultivation faces several challenges, related to availability of locations with sufficient sunshine and water, required nutrient inputs, and oil extraction (Darzins et al., 2010; USDOE, 2010). The most anticipated biofuel products appear to be high-quality diesel and jet fuel analogues, since few alternatives exist to replace these fuels. However, cultivation of algae and extraction of the oil is currently expensive. Production cost estimates for the raw oil vary between USD 0.75/l to more than USD 5.00/l, excluding costs for conversion to biofuel (Darzins et al., 2010). Optimization of algal strains, concerns over unwanted or adverse effects due to contamination, and scaling up production remain significant challenges to the development and commercialization of algae-based biofuels, and require more basic R&D efforts than other advanced biofuel routes. Commercially viable production of biofuel from algae will depend on effective strategies to generate high-volume, low-value biofuel along with high-value co-products.

5. RECYCLED COOKING GREASE AND OIL

It may not sound pleasant, but waste products like used cooking oil and grease can be used as cheap feedstocks. They are attractive as fuel sources because they're both environmentally friendly and inexpensive. The issues regarding land use, energy consumption and environmental impact that often surround growing feedstocks like corn, sugarcane and palm trees, can be eliminated by using something that already exists and needs to be disposed of anyway. "Yellow grease," a term for recycled cooking oil that may include soy, palm or canola oil, is one type of waste product being used as fuel. Of course it's not possible to simply pour used restaurant grease into your car's gas tank; it must first be processed to remove impurities and turned into clean-burning fuel.

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The Role of Ayurveda In Modern Animal Health Care

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The world is endowed with many systems of medicine: Allopathy, Homeopathy, Ayurveda, the Arabic, the Egyptian, and the Graeco-Roman etc. While the western system has entrenched itself with multiferous growth, there is growing awareness of the distinctive efficacy of systems like Ayurveda.The Indian system known as Ayurveda originated as far back as 2000 B.C. Ayurveda is a compound word in Sanskrit meaning literacy, the science of life, actually it implies two connected ideas- the sciences of life and art of living.Ayurveda unlike Allopathy or Homeopathy does not swear by any particular principle of cure. Ayurvedic treatment covers all the principles of Allopathy, Homeopathy and Naturopathy.Livestock production has been proved to be one of the effective tools in bringing about socio-economic changes of rural people. This is a greatful tool to produce rural unemployment which is estimated to raiseup to 120 million by 2000 A.D. The Dairy Development Programme cannot possibly succeed unless and until a well organized animal health cover is available and protection against dreadful animal diseases is assured.

At present large number of animals remain untreated for various ailments partly due to non-availability of drugs or higher cost of drugs. Due to poor economic standard, our livestock owners cannot afford to take up costly treatment. Hence, there is urgent need to develop low priced indigenous drugs in veterinary practice. The term indigenous drugs usually implies to herbal medicines i.e. the drugs derived from medicinal plants which are native to a particular country to locality. These herbal medicines have been dealthwith in 'Ayurveda or Baidyashastra which is an up gain of Atharvaveda. The materiamedica of Ayurvedic system embraces a vast spectrum of drugs belonging to herbal medicines. It has been roughly estimated that 1100, 1270, 1150 of Sanskrit names of plants are mentioned in Charka, Susruit and AstangaHaridayaSarnhita respectively. In addition to these the later works such as ModhobaNidana, Chikistha, Sargangraha, DhonwantariNigahta, ModanpalaNignanta and Bhavapraksh show that approximately 8000 herbs medicines were known to the Ayurvedists, out of these more than 2000 remedies of plant origin have

been mentioned for their use in veterinary practice.

Drugs like morphine, digitoxin, quinine, atropine, reserpine, etc have unpreceded usefulness in curing many of the ailments. These were obtained from indigenous medicinal plants only. Oscimum sanctum (Tusli) has anti mauseatic, anti helmnthic and antiseptic properties. The powder comprising of misture of dried Tulsi leaves, dried Tulsi root and lime in a proportion of 2:2:1 respectively can be used for treatment of ringworm and itches yield 0.7% essential oil which possesses anti-bacterial properties because it inhibits in growth of Mycobacterium tuberculosis, Staphylococcus aureus and streptococcus pyogens. The Indigenous durgs available where the cost is very low, cheap as compared to allopathy medicines for treatment of mastitis medicines of this composition. LimbulphoolTikadiNasador, Kalami Soda, each 50gms. Ras Kapoor-5gms to drenched in one litre of water (one dose of medicine) are used. Neem has deworrming property. A new herbal products "Trichasanthin" has been discovered by scientist of China used to facilitate expulsion of plecenta after birth in dairy cows.

The knowledge of medicinal properties of plants are based on folk lore medicine Scientific curiosity should stimulate the interest of the practitioners on indigenous medicinal plants with which India is rich in her heritage.Livestock is considered as industry which contributes significantly to the counts economy. Hence, the application of indigenous drugs on the increased production of milk, eggs and meat should be investigated. In recent years a large number of indigenous medicinal preparations are marketed for veterinary practice. These drugs are not only cheap but are safe as well, when compared to synthetic ones. Further, the residue of those drugs or their metabolites in the milk, egg or meat seems not much harmful for human consumption. The ever increases need of human beings and livestock is creating a broad scope of indigenous medicines.

The active principles present in the plants have some definite pharmacological action on the animal body. One difficulty in assessment in activities of herbal drugs that they may be powerful in the country of their origin but comparatively inactive in other places. In tropical countries like India the fervidsun, a humid air and the teeming soil give extraordinary energy to vegetable life. Hence the Indian natives recognized the existence of potent herbs which were unknown to European practitioners. The philosophy of Ayurvedic medicines is one of the factors for retarded progress in indigenous medicines. The science did not pay much importance on the etiology of the disease but concentrated as how to dispel it. However, one should not cherish the motive of doing some extra ordinary work on indigenous plants.

Further while doing research on indigenous drugs one should be careful in analytical versus holistic approach to the medicinal effect of plants. Analytically a given medicine (plant) may have several active principles with

the possibilities of are concerned. Even when a model of two principles are considered, four probable combinations can be taught of (1) One having nothing to do with other's action mutually, exclusive, (2) Two having the same active dichotornus , (3) One having diagonally opposite action to other-antagonistic Sarpagandha is an example of this type of both hypertensive and hypertensive principles. In the opinion of some Ayurvedic experts there is a latent dynamic power in the whole plant or drug which is last in the process of analysis. Thus yielding no active principle of convincing nature. We have also heard of a simple medicine being effective for several diseases with change of mode of preparation or mode of administration.

The active principles present in the plants have some definite pharmacological actions on the animal body. Plants are used in Unani, Ayurvedic and Allopathic medicines. As such, at one time, it was essential for the practitioners to have a broad botanical knowledge. Now a day's majority of the drugs are of synthetic origin. Hence, pharamcognosy is considered of limited importance. Many of the synthetic drugs were obtained by alteration of original structure of the active principles obtained from plant materials. The veterinary practitioner is equipped with knowledge in multi-disciplinary areas. Hence, they should sincerely attempt to find out the therapeutic significance of all indigenous medicines marketed. They should not depend on the tall claims made by exponents of such drugs. Each drug should be subjected to clinical test depending on its therapeutic applicability.

Potency of plant samples vary depending on soil, seasons of cultivation and harvesting, conditions of collection and storage. Often some promising medicinal plants are rejected by overlooking the season of collection and storage which have great impact on the potency of the material. Sometimes, effects of the plants are not correctly oberserved due to limitations of exploitation of indigenous plants, the investigation work should be left under the guidance of sincere, honest and efficient workers.

The indigenous drugs in addition to being low priced are readily available in the village market. In addition, these drugs reduce the problem of drug resistance and also public health hazards. However, some practitioners discourage the use on the grounds that they are mostly used in crude form. The number of plants is used, which might have antagonistic effect, and there may be toxicity in some products. However, the aim of preparing sidda medicine and complete group in Ayurveda is to overcome toxicity and antagonism by use of numbers of medicinal plants were toxic effect of one is detoxified by others and there synergism rather than antagonism. As such they are quite safe.
The problem in research in modern scientific lines in indigenous medicine includes:-

1. Lack of standardization methods
2. Variability of yield of active components of a plant depending on species soil, season, latitude, manner of curing.

3. Different plants have same name and same plants with different names
4. Sometimes frustrating results.
5. Difficulty in collaboration with others.
6. Deficiency of organized literature.
7. Data is scattered widely in various disciplines like Botany, Chemistry, Pharmacology, Medicines etc.

However, with all these difficulties research work is in progress both in government and private sector. A government of India have established a Council for Research in Ayurvedic Medicines and have different research centers throughout the country by the ICMR has taken up the task of publishing "A glossary of Indian Medicinal plants" which will go a long way in helping research work in Ayurveda.

Many private firms are now engaged in conducting research on herbal drugs animal use and they have been contributing means for taking up research herb in different veterinary institutions M/s. Indian Herbs, M/s. Alarsin, M/s. Himalayan Drug co. Natural Remedies Indian Ltd. M/s. Respal Pharma have pioneered manufacture of Ayurvedic veterinary drugs which have been received international acclaim especially in developing countries like Malaysia , Thailand and Middle East countries. Topicure Herbal care, WISPREC- udder care, Himax-Dermal care, NATCOF-Respiratory care, ZIGBIR- Liver Care, ZIST- Liquid Immune care, Mammi guard-udder care. HIMALAYAN BATISA for better animal health and farm productivity. TIMPAL-treats the cause and effect of blood, NEBLON-checks diarrhea immediately and effectively, LIVOL tones up the liver for better animal health, REPLENTA- urine tonic, GALOG- restores regulates and optimizes milk yield, PRAJANA- ensure efficientbreeding COFECU-peps up health, production and reproductive efficiency, CAFLON- comprehensive therapy for cough and coryza, WOPELL-for eradication of G.I Helminthes, TAENIL for complete eradication of tapeworms, TTBURB+ systematic support to skin therapy, BLAZE-for total skin care, PESTOBAN-eradicates ectoparasites, effectively, HIMAX-brood spectrum dermatological, HERBOSAL-digestive tonic powder, DIASEL-stringentand antidiarrhoeal powder, COFSPEL- expectorant powder, BLOTOSPEL-antizyomotic powder, RESANT-antiseptic and parasitical skin oint, NUTOSPEL-general tonic powder, RESANT-antiseptic and panasiticidal skin oint, NUTROSPEL-general tonic powder, HIT-RIT-oestrus inducer. These are the herbal medicines widely used in veterinary practice and so many other herbal medicines are also used now a days for treatment purpose.

Annona Squamosa leaf extract for acaricidal effect and MomordicaChoronitia leaf extract for its fabrigunge effect-on the basis of compilations available in vernacular like adarshapashuchikitsha, SahojaGochikitas and palm leaf manuscripts and collections on the effect of some plants in animal treatment by the rural people can further be used to try these products on

scientific lines on experimental models. Research in this line throughout the country both by Government and private organizations will minimize imports of foreign drugs and will help the poor livestock owners at large.

Identification and Prediction of Illness Based on the Dairy Cow Behaviour

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Maintaining the healthy dairy herd is a major challenge in the commercial dairy farming.The measures of behaviour can be used to predict and identify healthy and welfare concerns in dairy cattle (van Keyserling *et al*., 2009).Now days, the behavioural study is an important one, due to the changes in the small scale dairy production to large scale commercial dairy production, thereby warranting the easy identification of problems in the herd.The union between health and behaviours are quiet interesting, because most of these health problems are affecting the normal behaviour of the cow, particularly; mastitis, lameness, metabolic and infectious diseases. These types of health problems not only affect the cow's welfare, it also can affect the efficiency and productivity of the dairy cow. This paper depicts few behavioural alterations which can be used to predict the illness of the dairy herd.

"The Study of behaviour related with health problems are an important one in the commercial dairy production. Because, most of the health related problems are affecting the normal dairy cow behaviour. These health problems are reducing the welfare as usual as the performance of the cow. In this reason, the dairy cow behavioural deviation is a tool to uses the identification of diseases and maintains the healthy herd in dairy production."

RUMINATION BEHAVIOUR AND ACIDOSIS:

In dairy cattle, the normal optimal rumen pH range is 6.2 – 7.2. When cow consumed excessive amount of grains (or) concentrates with low intake of forages, the rumen pH goes down, below the normal range. This sub-optimal rumen pH (5.2 to 5.8) is called as Sub-acute ruminal acidosis (SARA) and below this sub-optimal ruminal pH(<5.2) is called as acidosis. The special features of the disease SARA is lack of specific clinical symptoms. This disease is indirectly affecting the dairy cow productivity due to reduced feed digestibility, inconsistent dry matter intake(DMI), diarrhoea and laminitis. In a healthy dairy herd, at least 40% of the cows should be ruminating at any given time (Eastridge, 2000), but when the

rumination ratio is less than 40 % then the herd can be suspected for Sub acute ruminal acidosis and when the same ratio is less than 10 % then there is possibility of acidosis.

Feeding behaviour relating to infectious andmetabolic diseases:

The period between 21 days prior and 21 days after calving is called as transition period. During this period thedairy cows are quiet vulnerable to metabolic and infectious diseases. It have been reported that cows diagnosed with acute metritis after calving spent less time in feeding during the 12 days to 2 days before calving (Urton *et al*., 2005); and less dry matter intake (Hazzey *et al*., 2007). The average feeding time of dairy cow is 3 – 5 hours (9 -14 meals) per day in free-stall environment condition (Grant and Albright, 2000). During the last month of gestation, cows were 1.7 times more susceptible to metritis for every 10 min decrease in the feeding time. For every 1 kg decrease in dry matter intake (DMI) during this period, cows are also nearly 3 times more susceptible to metritis.Similar findings, also reported by Goldhawk *et al.,* (2009) that cows developed subclinical ketosis during one week before calving. These metritis and subclinical ketosissusceptible cows have aggressive behaviour at the feeding station during the peak feeding time, resulting in displacement of feed bung and wastage of feed, which furtherleads to decreased feeding time and DMI in dairy animals.

STANDING BEHAVIOUR AND MASTITIS:

Inflammation of mammary gland due to any physiological and pathological causeis called as mastitis. Occurrence of mastitis is more common after milking, because immediately after milking the teat orifice won't be closed favouring the entry of pathogens into udder.Cow's time of standingafter milking is associated with its mastitis infection.The occurrence of mastitis can be reduced when the cow is made to stand for a longer time following milking, thereby preventing the entry of microbes from the floor to the udder/ teat orifice.Presence of fresh feed in the bunk encourages longer post-milking standing times (DeVries and von Keyserlingk, 2005). After milking, when the cows standing time was 40 – 60 min, prevalence of subclinical mastitis was less compared to those that lay down within 40 minutes. When the post milking standing time exceeds 60 min there will be increased susceptibility to mastitis,because ofincreased teat bacterial penetrability caused by pressure, due to the accumulation of milk within the teat and gland cisterns.

STANDING BEHAVIOUR AND LAMENESS:

Proudfoot *et al*. (2010) reportedthat cows having sole lesions and ulcers in mid-lactation stood for longer periods of time during the 2 weeks prior and 24 hour after calving compared to those cows that retained good hoof health during that time period. The inflammation of lamina propriais termed as lameness. Such types of conditions were mostly caused by high carbohydrate feeding and concrete floor type housing. Lamenessoccursmostly during the transition period of the dairy herd, due to sudden change of feeding and social group. This type of conditions directly

affects the resting period (normal resting period 12 – 14 hours per day) and indirectly affects the performance (feeding and production) of the dairy cattle. When animal is standing more time, lying and eating are restricted simultaneously, cows choose to rest rather than eat. With an additional1.5 hr/day standing time associated with a 45-min reduction in feeding time (Metz, 1985).

CONCLUSIONS

Behaviour isan important tool to identify and predict the health problems of the dairy herd. Most of the health problemsaffect the normal behaviours (e.g. rumination, feeding and standing behaviour) of the dairycows. These problems arearising mainly during the transition period of the herd.Deviations from the normal behaviour indirectly indicate the reduced performance of the herd. So, we should aim that the herd exhibit normal behaviour for attaining the maximum productivity.

Applications of Bio-control agents in Plant Disease Management

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Plant diseases need to be controlled to maintain the quality and abundance of food, feed, and fiber produced by growers around the world.The total loss as a consequence of plant diseases could be as high as 25 per cent of the yield in western countries and almost 50 per cent in developing countries. Different approaches may be used to prevent, mitigate or control plant diseases. Among them indiscriminate use of chemicals to overcome the pathogens has caused enhancement of overhead costs, accumulation of toxic chemical residues in food chain and soil pollution leading to loss of soil health. Apart from this, the chemicals tend to become less efficient due to the development of resistance among the pathogens over time scale. Under these circumstances, the use of various eco-friendly biocontrol agents is increasingly being emphasized as an important component of the integrated pest management. The concept of biocontrol embodies introduction of antagonists into cropping systems. A living multiplying biocontrol agent potentially provides a continuous, non chemical control of pathogen. Moreover chemical measures may establish imbalance in the micro-biological community i.e. unfavorable situation for activity of beneficial organisms. So direct application of antagonist would be safer method for introducing microorganisms into the soil for biological control of soil borne plant pathogen.

Biological control is the reduction of inoculum density or disease producing activity of a pathogen or a parasite in itsactive or dormant state by one or more organisms accomplished naturally or through manipulation of the environment of host or antagonist by mass introduction of one or more antagonists (Baker and Cook, 1974).

Mechanisms of biological control

Biological control can result from many different types of interactions between organisms, researchers have focused on characterizing the mechanisms operating in different experimental situations. In all

cases, pathogens are antagonized by the presence and activities of other organisms that they encounter. Different mechanisms of antagonism occur across a spectrum of directionality related to soil born plant pathogen are mentioned below:

1 DIRECT ANTAGONISM: Direct antagonism results from physical contact and/or a high- degree of selectivity for the pathogen by the mechanism expressed by the biocontrol agents. In such a scheme, hyperparasitism by obligate parasites of a plant pathogen would

be considered the most direct type of antagonism because the activities of no other organism would be required to exert a suppressive effect.

a)Hyperparasitism/predation: A Phenomenon in which one parasite parasitic on another parasite either by direct parasitism or lysis and causes death of the pathogen.

2 Indirect antagonism:

Indirect antagonism results from activities that do not involve sensing or targeting a pathogen by the biocontrol agents. Stimulation of plant host defense pathways by non-pathogenic biocontrol agents is the most indirect form of antagonism. However, in the context of the natural environment, most described mechanisms of pathogen suppression will be modulated by the relative occurrence of other organisms in addition to the pathogen. It includes competition between pathogen and biocontrol agents for substrate.

1. Competition:

Biological agents compete with

Antagonistic activity of *Trichoderma viride* against *fusarium udum in vitro*

plant pathogens for space, organic nutrients and minerals. Most aerobic and facultative anaerobic micro-organisms respond to low iron stress by producing extracellular, low molecular weight (500-1000 daltons) iron transport agents, designated as Siderophores, which selectively make complex with iron (Fe+) with very high affinity. Siderophore producing strains are able to utilize Fe+ - Siderophore complex and restrict the growth of deleterious micro-organisms mostly at the plant roots. Iron starvation

Antagonistic activity of *Trichoderma viride* against *Rhizoctonia bataticola in vitro*

prevents the germination of spores of fungal pathogens in rhizosphere as well as

rhizoplane. Eg. Siderophores produced by *Pseudomonas fluorescens* (known as pseudobactinsor pyoveridins) helps in the control of soft rot bacterium, *Erwinia caratovora*. suppression of *Pythium ultimum* by *Enterobacter cloacae*, *P. putida* colonize the root system in the rhizosphere and a corresponding reduction in Fusarium wilt suppression in cucumber.

2. Induction of host resistance:

Plants actively respond to a variety of environmental stimuli, including gravity, light, temperature, physical stress, water and nutrient availability. Plants also respond to a variety of chemical stimuli produced by soil- and plant-associated microbes. Such stimuli can either induce or condition plant host defenses through biochemical changes that enhance resistance against subsequent infection by a variety of pathogens.

1) Systemic acquired resistance (SAR): SAR is mediated by salicylic acid (SA), a compound which is frequently produced following pathogen infection and typically leads to the expression of pathogenesis-related (PR) proteins. These PR proteins include a variety of enzymes some of which may act directly to lyse invading cells, reinforce cell wall boundaries to resist infections, or induce localized cell death.

2) Induced systemic resistance (ISR): ISR is mediated by jasmonic acid (JA) and/or ethylene, which are produced by applications of some nonpathogenic rhizobacteria.

3. Lytic enzymes secreted by biocontrol agents:

Diverse microorganisms secrete and excrete other metabolites that can interfere with pathogen growth and/or activities. Many microorganisms produce and release lytic enzymes that can hydrolyze a wide variety of polymeric compounds, including chitin, proteins, cellulose, hemicellulose, and DNA. Expression and secretion of these enzymes by different microbes and sometimes result in the suppression of pla nt pathogen activities directly. eg. Control o f *Sclerotium rolfsii* by *Serratia marcescens* appeared to be mediated by chitinase expression and, a b-1,3-glucanase contributes significantly to biocontrol activities of *Lysobacterenzymogenes* strain C3.

3. Antibiosis:

Antagonism mediated by specific or non-specific metabolites of microbial origin, by lytic agents, enzymes, volatile compounds or other toxic substances is known as antibiosis. Most microbes produce and secrete one or more compounds with antibiotic activity. In some instances, antibiotics produced by microorganisms have been shown to be particularly effective at suppressing plant pathogens and the diseases they cause.

a) Antibiotics:

A chemical compound produced by one microorganism that inhibits or kills other microorganisms. Eg: *Gliocladium virens*produces gliotoxinthat was responsible for the death of *Rhizoctonia solani* on potato tubers, Colonization of pea seeds by *Trichoderma viride*resulted in the

accumulation ofsignificant amount of the antibiotic viridian in the seeds, thus controlling *Pythium ultimum*, Some strains of *Pseudomonas fluorescens*produce a range of compounds, viz., 2,4-diacetyl phloroglucinol (DAPG), phenazines, pyocyanin, which have broad spectrum activity against many plant pathogenic bacteria and fungi.

b) Bacteriocins:

Bactericidal substances produced by certain strains of bacteria and are active against some other strains of the same or closely related species. Eg: The control of crown gall (caused by*Agrobacterium tumefaciens*) by the related *Agrobacterium radiobacter*strain K 84 is by the production of bacteriocin, Agrocin K84.

Important fungal biocontrol agents:

Most of the species of *Trichoderma*, viz., *T. harzianum*, *T. viride*, *T. virens* (*Gliocladium virens*) are used as biocontrol agents against soil borne diseases, such as, root rots,seedling rots, collar rots, damping off and wilts caused by the species of *Pythium*, *Fusarium*, *Rhizoctonia*, *Macrophomina*, *Sclerotium*, *Verticillium*, etc. Formulations of biocontrol agents available: *T. viride*(Ecofit, Biodermain India), *G. virens* (GlioGardin USA), *T. harzianum*(F-Stopin USA) and *T. polysporum*(BINABT)

Important bacterial biocontrol agents:

1. *Pseudomonas fluorescens*(**Dagger-G**against damping off of cotton seedlings)
2. *Bacillus subtilis*(**Kodiak**against damping off and soft rot)
3. *Agrobacterium radiobacter* K-84 (**Gallex**or **Galltrol**against crown gall of stone fruits caused by *Agrobacterium tumefaciens*).

#	Biocontrol agent		Parasitized on
1	*Trichoderma harzianum* (Fungi) *Trichoderma viride* (Fungi)	:	*Rhizoctonia* spp., *Sclerotium* spp., *Fusarium* spp.
2	*Ampelomyces quisqualis* (Fungi)	:	Powdery mildew fungi
3	*Pichia gulliermondii* (Fungi)	:	*Botrytis*, *Penicillium*
4	*Pasteuria penetrans* Bacteria)	:	Juvenile parasite of root knot nematode
5	*Paecilomyces lilacinus* (Fungus)	:	Egg parasite of *Meloidogyne incognita*

Indirect antagonism	**a)**	**Antibiotics**	**:**	**2,4-diacetylphloroglucinol**
	b)	**Lytic enzymes**	**:**	Chitinases, Glucanases, Proteases
	c)	**Unregulated waste products**	**:**	Ammonia, Carbon dioxide, Hydrogen cyanide
	d)	**Physical/chemical interference**	**:**	Blockage of soil pores, Germination signals consumption, Molecular cross-talk confused
	e)	**Competition**	**:**	Exudates/leachates consumption, Siderophore scavenging, Physical niche occupation
	f)	**Induction of host resistance**	**:**	Contact with fungal cell walls, Detection of pathogen-associated molecular patterns, Phytohormone-mediated induction

Use of Feed Acidifiers in Poultry

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Feed Acidifiers are acids included in feeds in order to lower the pH of the feed, gut, and microbial cytoplasm thereby inhibiting the growth of pathogenic intestinal microflora. This inhibition reduces the microflora competing for the host nutrients and results in better growth and performance of the chicken. They also act as mold inhibitors. They are added upto 0.25% of the diet. Most acids are efficacious and their effect remains as long as the acid is not volatilized. Organic acids have been used extensively for more than 25 years in swine production and more recently in poultry. The antimicrobial effect of organic acid ions in controlling bacterial populations in the upper intestinal tract leads to beneficial effects. Inorganic acids such as HCl and H_3PO_4 though pH reducing are ineffective. Organic acids are organic carboxylic acids, including fatty acids and amino acids, of the general structure R-COOH. The short chain acids (C_1-C_7) are associated with antimicrobial activity. They are either "Simple monocarboxylic acids such as formic, acetic, propionic and butyric acids or "Carboxylic acids with hydroxyl group such as lactic, malic, tartaric and citric acids or "Short chain carboxylic acids containing double bonds like fumaric and sorbic acids. Organic acids are weak acids and are only partly dissociated. Most organic acids with antimicrobial activity have a pKa-the pH at which the acid is half dissociated between 3 and 5.

Form of organic acids incorporated

- ✓ Free acid form (powder or liquid)
- ✓ As salts form

a) Free form

b) Protected / Coated salts

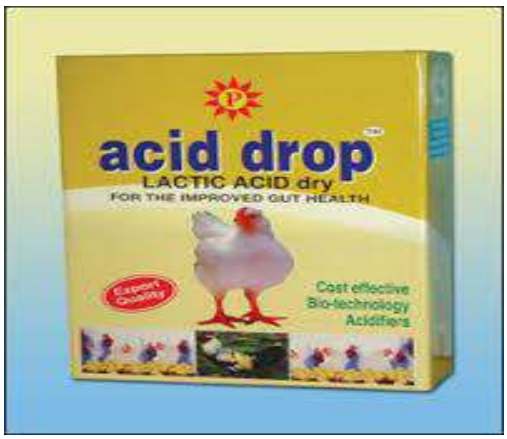
Inclusion levels of organic acids

- ✓ 0.5 kg / Ton of feed to control molds
- ✓ 2.5 to 3.0 kg / Ton of feed to reduce pH and help in control of Salmonella

Site of Action

Organic acids exert their antimicrobial action both in the feed and in the GI-tract of the animal. The antibacterial effect of dietary organic acids in chickens is believed to occur in the upper part of the

digestive tract (crop and gizzard). Following the addition of a combination of formic and propionic acid, high concentrations of these acids could only be recovered from crop and gizzard.



Mode of Action

The antibacterial action of organic acids depends on whether the bacteria are pH sensitive or not. Only certain types of bacteria are sensitive to pH (ex.: *E. coli, Salmonella sp., L. monocytogenes, C. perfringens*) while other types of bacteria are not sensitive (*Bifidobacterium sps., Lactobacillus sps*).

A. For pH sensitive bacteria:

Organic acids in undissociated (non-ionized, more lipophilic) state penetrate the semipermeable membrane of bacteria cell wall and enter cytoplasm. At the internal pH of bacteria (~7.0), the undissociated organic acids dissociate, releasing H+ and anions (A-). The internal pH of bacteria decreases. The pH sensitive bacteria are unable to tolerate a large spread between the internal and the external pH. A specific H+ -ATPase pump acts to bring the pH inside the bacteria to a normal level. This phenomenon consumes energy and eventually can stop the growth of the bacteria or even kill it. The lowering of pH also suppresses the enzymes (e.g. decarboxylases and catalyses), inhibit glycolysis, prevent activetransport and interfere with signal transduction. The anionic (A-) part of the acid trapped inside the bacteria (it can diffuse freely through the cell wall only in its non-dissociated form), becomes toxic involving anionic imbalance leading to internal osmotic problems for the bacteria.

B. For non-pH sensitive bacteria:

The non-pH sensitive bacteria tolerate a larger differential between internal and external pH. At a low internal pH, organic acids reappear in a non-dissociated form and exit the bacteria. Equilibrium is created and the bacteria do not suffer.

FACTORS INFLUENCING THE EFFICACY

- ✓ pKa-value
- ✓ Chemical form (acid, salt, coated or not),
- ✓ Molecular weight
- ✓ MIC-value of the acid
- ✓ Kind of micro-organism
- ✓ Animal species,
- ✓ Site and location in the GIT
- ✓ Buffering capacity of the feed

Impact of organic acids on broiler performance

Organic acids are beneficial in practical studies. The efficacy of poultry digestion depends on microorganisms, which live naturally in the digestive tract. Inclusion of formic and propionic acids reduced pH in crop and gizzard but not in intestinal tract. Organic acids in crop reduce *salmonella* populations. Organic acids reduce production of toxic components by bacteria and a change in the morphology of the intestinal wall and reduce colonization of pathogens on the intestinal wall, thus preventing damage to the epithelial cells. Various studies revealed that body weight gain, feed intake, feed conversion rate, carcass weight, abdominal fat weight, abdominal fat percentage, intestinal weight were affected significantly ($P<0.05$) by giving organic acid mixtures. Organic acids enhance growth performance and carcass quality of broiler chicks.

Beneficial effects

- ✓ To help maintain an optimum pH in the stomach, allowing correct activation and function of proteolytic enzymes.
- ✓ Total protein digestion in the stomach
- ✓ To stimulate feed consumption.
- ✓ To inhibit the growth of pathogenic bacteria.
- ✓ Improves protein and energy digestibilities by reducing microbial competition with host nutrients and endogenous nitrogen losses.
- ✓ Lowers the incidence of sub clinical infections and secretions of immune mediators.
- ✓ Reduces the production of ammonia and other growth depressing microbial metabolites.
- ✓ Increased pancreatic secretion and trophic effects on gastrointestinal mucosa.

LIMITATIONS

- ✓ Palatability may be decreased**,** leading to feed refusal
- ✓ Organic acids are corrosive to metallic poultry equipment
- ✓ Bacteria are known to develop acid resistance when exposed to acidic environments for over long term
- ✓ Presence of other antimicrobial compounds can reduce its efficiency
- ✓ Cleanliness of the production environment
- ✓ Buffering capacity of dietary ingredients

New developments

Organic acids can be mixed with fatty acids, mono- and diglycerides to form microgranules. Organic acid is released slowly from these microgranules. Medium chain fatty acids (chain length: 6 to12 C) with a lower absorption rate by the host may improve the efficacy of the short chain fatty acids. Acids produced by fermentation with microbes (*Pediococcus acidilactici)* may be less expensive and equally effective.

CONCLUSIONS

Prevention of infections, good nutritional balance and better performance is of paramount

importance in poultry production. The use of alternatives to antibiotic growth promoter in specific the use of organic acids in poultry feed is receiving greater

attention. It is hoped that nutritional control will lead to microbiological control, allowing for more consistent performance response in the absence of antibiotics. In the absence of antibiotic growth promoters, nutrition and feeding strategies must supplement, not be a substitute for good management. The use of acidifiers in poultry diets appears promising. Combination of different acids seems to lead the way to greater efficacy.

Climate Change and Agriculture

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Climate change has emerged as a serious global environmental issue having impact on all forms of life. It increases the greenhouse gases like carbon dioxide, nitrous oxide, ozone and methane which may cause impact in terms of increased temperature, more demand for water and increase in biotic and abiotic stresses. Climate change is defined as "*change in climate over time, whether due to natural variability or as a result of human activity*". Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, to cope with the consequences. Weather is the condition of the atmosphere at a particular place and time. It is characterized by parameters such as temperature, humidity, rain and wind. Climate is the long term pattern of weather conditions for a given area. Climate change refers to a statistically significant variation in either the mean state of the climate or its variability, persisting for an extended period. India is home to extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. The nation's climate is strongly influenced by the *Himalayas* and the *Thar* Desert. Four

Year	Season	Increase in Temperature, °C		Change in Rainfall, %	
		Lowest	Highest	Lowest	Highest
2020s	Rabi	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.12	1.81	5.10
2050s	Rabi	2.54	3.18	-9.22	3.82
	Kharif	1.81	2.37	7.18	10.52
2080s	Rabi	4.14	6.31	-24.83	-4.50
	Kharif	2.91	4.62	10.10	15.18

Figure 1 Climate Change Scenarios for India

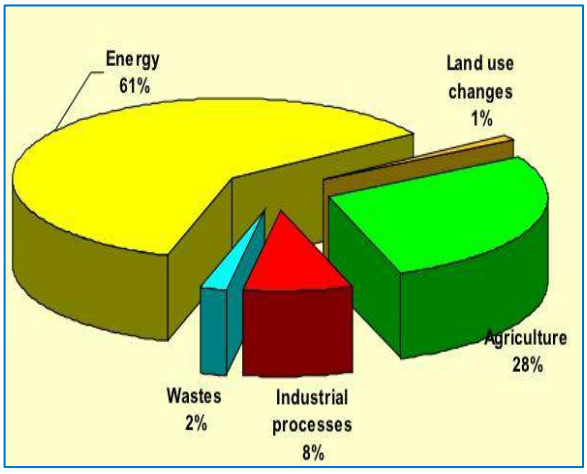


Figure 2 What is the contribution of different sectors in India to climate change?

major climatic groupings predominate into which fall seven climatic zones which are defined on the basis of temperature and precipitation.

Figure 5 Source:http://pubs.sciepub.com

The greenhouse effect :

The earth is surrounded by an atmosphere through which solar radiation is received. The atmosphere is not static but contains air, in constant motion, being heated, cooled and moved, water being added and removed along with smoke and dust. Only a tiny proportion of the sun's energy reaches earth and some of this is reflected back into space (from clouds etc.). When the radiant energy reaches the land surface, most of it is absorbed, being used to heat the earth, evaporate water and to power

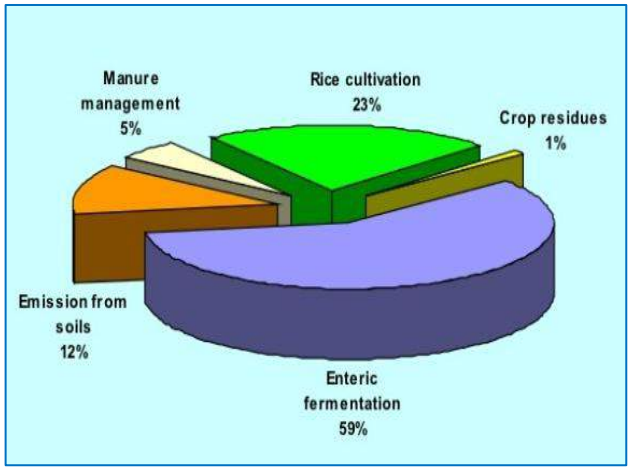


Figure 3 What sectors of agriculture in India contribute to climate change?

photosynthetic processes. The earth also radiates energy but, because it is less hot

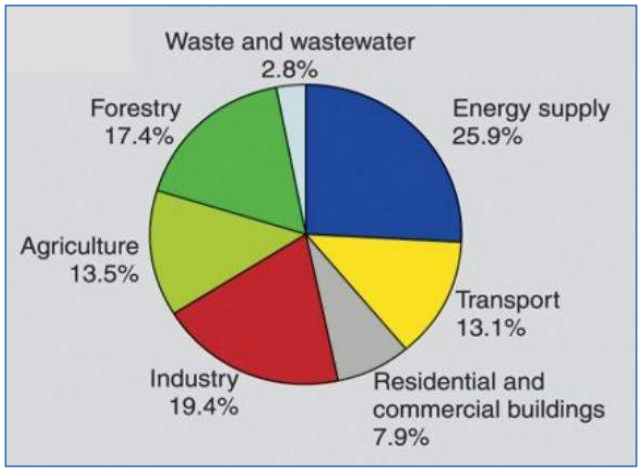


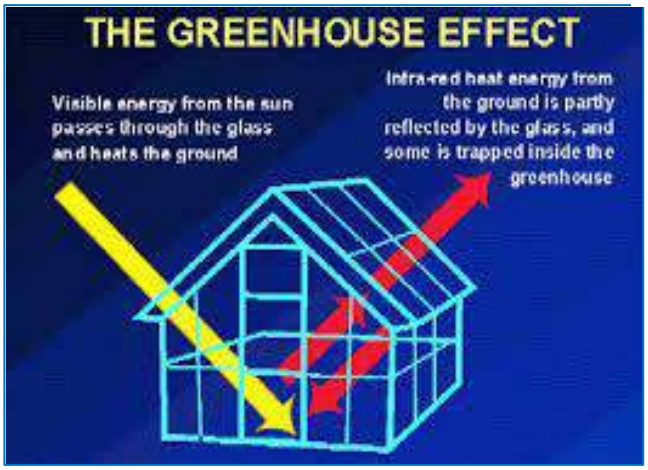
Figure 4 Contribution of different sectors in world to climate change

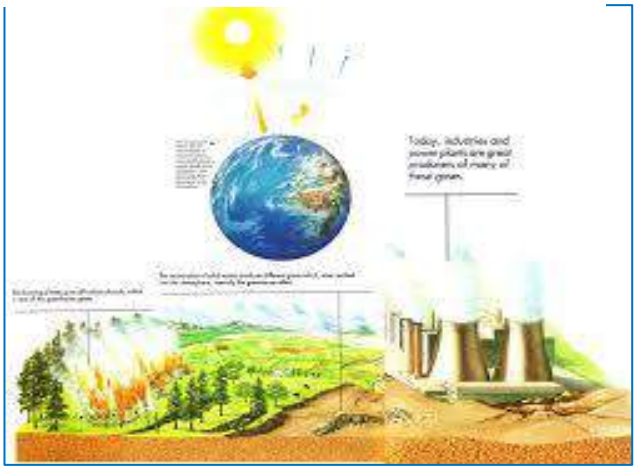
than the sun, this is of a longer wavelength and is absorbed by the atmosphere. The Earth's atmosphere, thus acts like the glass of a green house, hence the 'greenhouse effect'. The greenhouse gases (dealt with in subject 3) are those that absorb the Earths radiation and thus contribute to the greenhouse effect, but water is also a major absorber of energy. Where there is an increase in

the concentration of greenhouse gases (as with CO2 due to the burning of fossil fuels) these results in an enhanced greenhouse effect which is of concern as it could lead to climate change (i.e. global warming).

Global warming

Global temperatures have risen by over 0.7°C in the last 100 years and eleven of the last twelve years (1995-2006) are the warmest on record. In the UK in 1990s





were very warm about 0.6°C warmer than the mean 1961 1990 temperature. Warm winters have reduced the number of frosts, and the warmer summers have included record hot spells and high sunshine totals.

Climate Change and Indian Agriculture

- Large country with diverse climate
- Two thirds area rain dependent
- High monsoon dependency
- Diverse seasons, crops and farming systems
- Close link between climate and water resources
- Small holdings, poor coping mechanisms and mechanisms and low penetration of penetration of risk management products

In the long run, the climatic change could affect agriculture in several ways:

- Productivity, in terms of quantity and quality of crops
- Agricultural practices, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers
- Environmental effects, in particular in relation of frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, reduction of crop diversity
- Rural space, through the loss and gain of cultivated lands, land speculation, land renunciation, and hydraulic amenities.
- Adaptation, organisms may become more or less competitive, as well as humans may develop urgency to develop more competitive organisms, such as flood resistant or salt resistant varieties of rice.

How will climate change effect agriculture?

Soil processes:

The potential for soils to support agriculture and distribution of land use

will be influenced by changes in soil water balance:

- Increase in soil water deficits i.e. dry soils become drier, therefore increased need for irrigation but:
- Could improve soil workability in wetter regions and diminish poaching and erosion risk

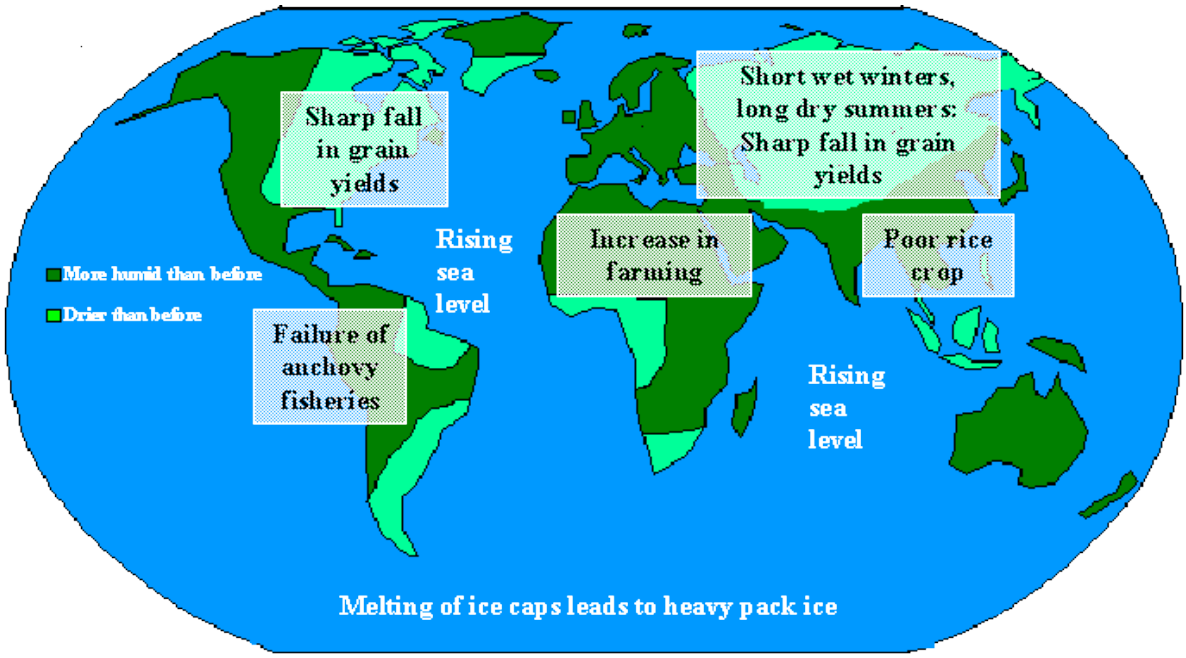


Figure 6 Figure 6 Consequences of 1oC rise in world's temperature

Crops

The effect of increased temperature and CO_2 levels on arable crops will be broadly neutral:

- The range of current crops will move northward
- New crop varieties may need to be selected
- Horticultural crops are more susceptible to changing conditions than arable crops
- Field vegetables will be particularly affected by temperature changes
- *Phaselous*bean, onion and sweetcorn are most likely to benefit commercially from higher temperatures
- Water deficits will directly affect fruit and vegetable production
- Higher CO_2 levels can increase yields. The yields for some crops, like wheat and soybeans, could increase by 30% or more under a doubling of CO_2concentrations.
- The yields for other crops, such as corn, exhibit a much smaller response (less than 10% increase).
- However, some factors may counteract these potential increases in yield. For example, if temperature exceeds a crop's optimal level or if

sufficient water and nutrients are not available, yield increases may be reduced or reversed.

How will climate change effect cropping in tropical and arid Countries?

Grasslands and livestock:

- There is unlikely to be a significant change in suitability of livestock
- Pigs and poultry could be exposed to higher incidences of heat stress, thus influencing productivity
- Increase in disease transmission by faster growth rates of pathogens in the environment and more efficient and abundant vectors (such as insects)
- Consequences for food quality and storage

Indirect effects: Irrigated crops

Climate change will have a direct impact on water availability for irrigated crops. Internal renewable water (IRW) is the water available from precipitation. In addition to precipitation changes, climate change-induced higher temperatures increase the water requirements of crops. The ratio of water consumption to requirements is called irrigation water supply reliability (IWSR). The smaller the ratio, the greater the water stress on irrigated crop yields. Yield reductions of irrigated crops due to water stress are directly estimated in the hydrology portion of IMPACT, taking into account the growing demand for water outside agriculture as well as agricultural demands.

Conclusion

1. Plantation should be increasing on the foot of *Himalaya*, *Sahyadri* ranges, costal area and barren land. With reference to Gujarat forest area should increase from9.5% to 20% in next decade or by 2020 AD.
2. For controlling methane emission from the paddy field, the appropriate water saving technology should be used instead of transplanting and submerged paddy cultivation method.
3. Shelter belts should be created near sea shore to check salinity and salt nuclei in atmosphere, which changes rainfall pattern.
4. The simulation results indicate that increasing temperature and decreasing solar radiation levels pose a serious threat in decreasing growth and yield of agricultural crops. Increasing CO_2 levels are expected to favor growth and increase crop yields and therefore, will be helpful in counteracting the adverse effects temperatures rise in future.

Indoor Plants in Combating Pollution

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Indoor air quality is an increasing health concern particularly in cities where people spend up to 90 per cent of their time indoors. Indoor air can be as much as 12 times more polluted than outside air in some areas, due to compounds in paints, furnishing, clothing and building materials. Thus the risk to health may be greater due to indoor air pollution than the outdoor air. The common indoor air pollutants are benzene, formaldehyde, carbon dioxide and trichloroethylene. These pollutants can cause leukemia, liver disease and a myriad of cancers. Research shows that many common houseplants and blooming potted plants can improve health by reducing these pollutants at home. Their leaf composition let them photosynthesize and move air efficiently in low light condition inside the house. Roots of the plants proved to play the most important role in cleaning and decomposing these pollutants. A study conducted by Stanley J. Kays at the University of Georgia found that some ornamental plants remove volatile organic compounds from indoor air (Healthline Editorial Team,2013). There is also a growing body of evidence showing direct measurable benefits to the health and well being of building occupants resulting from the capacity of pot plants to produce cleaner air (Carrer *et al*., 1999; Lim *et al*., 2006) as well as their ability to provide feelings of pleasure, calm and relief from fatigue (Shibata & Suzuki,2002). Some of the indoor plants useful in absorbing potentially harmful gases and cleaning air inside modern buildings are given below:

Bamboo palm (*Chamaedorea sefritzii*): Also known as the reed palm, this small palm thrives in shady indoor spaces and often produces flowers and small berries. It tops the list of plants best for filtering out both benzene and trichloroethylene. They're also a good choice for placing around furniture that could be off-gassing formaldehyde.

Chinese evergreen (*Aglaonema Crispum* 'Deborah'): This plant can help filter out a variety of air pollutants and begins to remove more toxins as time and exposure continues.

English ivy (*Hedera helix*): A recent study found that the plant reduces airborne fecal-matter particles. It has also been shown to filter out formaldehyde found in some household cleaning products.

Golden pothos (*Scindapsus aures*): It is a powerful plant for tackling formaldehyde. It is a fast-growing vine that creates a cascade of green from a hanging basket. Consider locating it near a door closest to your garage since car exhaust is filled with formaldehyde.

Heart-leaf philodendron (*Philodendron oxycardium*): Highly toxic when eaten, but it's a workhorse for removing all kinds of VOCs (volatile organic compounds). Philodendrons are particularly good at battling formaldehyde from sources like particleboard.

Peace lily (*Spathiphyllum* 'Mauna Loa'): Shade and weekly watering are all the peace lily needs to survive and produce blooms. It topped NASA's list for removing all three of most common VOCs — formaldehyde, benzene and trichloroethylene. It can also combat toluene and xylene.

Red-edged dracaena (*Dracaena marginata*): This plant is best for removing xylene, trichloroethylene and formaldehyde, which can be introduced to indoor air through lacquers, varnishes and gasoline.

Warneck dracaena (*Dracaena deremensis* 'Warneckii'): It combats pollutants associated with varnishes and oils with this dracaena. The Warneckii grows inside easily, even without direct sunlight.

Snake plant (*Sansevieria trifasciata* 'Laurentii'): Also known as mother-in-law's tongue, this plant is one of the best for filtering out formaldehyde, which is also common in cleaning products, toilet paper, tissues and personal care products. It thrive under low light and steamy humid conditions and help filter out air pollutants.

Spider plant (*Chlorophytum comosum*): With lots of rich foliage and tiny white flowers, the spider plant battles benzene, formaldehyde, carbon monoxide and xylene, a solvent used in the leather, rubber and printing industries.

Weeping fig (*Ficus benjamina*): A ficus in a living room can help filter out pollutants that typically accompany carpeting and furniture such as formaldehyde, benzene and trichloroethylene.

CONCLUSION

City building air-conditioners normally filter out dust (particulates) from incoming air, but don't remove gaseous pollutants. Indoor plants reduce all types of urban air pollution. Indoor plants must thus be kept inside houses, offices or buildings so as to minimize different health hazard problems.

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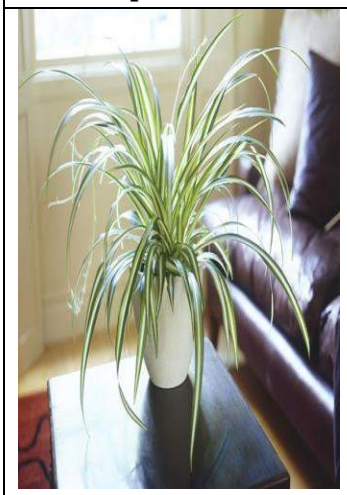
 **Golden pothos**	 **Weeping fig**	 **Snake plant**
 **Spider plant**	 **Peace lily**	 **English ivy**

Climate Change:

Adaptation and Mitigation for Fruit Crops

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Everyone's talking about the weather but nobody's doing anything about it.
-Mark Twain

CLIMATE CHANGE

"Climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC)

GREEN HOUSE EFFECT

Radiation reaching the planet is partly absorbed, causing the Earth to emit thermal radiation and part of the radiation is reflected back to the atmosphere. Water vapour and radioactively active CO_2, CH_4, N_2O and O_3 etc. partly trap the reflected radiation to warm the surface temperature, a natural phenomenon known as the **'Greenhouse Effect'.**The direct effect of this is to warm the earth's surface and troposphere or lower atmosphere. This process is known as green house effects.

INDIAN FRUIT FACTS

- India is second largest producer of fruit crops. Production of fruits 76.4 million tones, it's accounts for about 30 per cent of the total production of horticulture crops.
- The area under fruit crops during 2011-12 was 6.7 million ha, which is almost 29 per cent of area under horticulture in India.
- India accounts for 13 percent of the total world production of fruits and leads the world in the production of mango, banana, papaya, sapota, pomegranate, acid lime and aonla.(NHB 2013)

ADAPTATION

"The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2007).Climate change brings into focus the mutual relationship between society and nature.

Adaptation: Adaptation is the process through which people reduce the adverse effects of climate and adaptation measures

are meant to protect a community against projected climate change impacts.

Mitigation: A human intervention to reduce the sources or enhance the sinks of greenhouse gases, for example, reducing the carbon footprint of business operations by cleaner fuels, reducing electricity consumption, etc.

Types of climate change adaptation strategies for fruit crops

I. Short term climate change adaptation strategies
   i. Land and water management
   ii. Crop management
   iii. Nutrient management
   iv. Pest management
   v. Crop and Cultivar substitution

II. Long term climate change adaptation strategies
   i. Change in land use
   ii. Heat and drought tolerant crop varieties

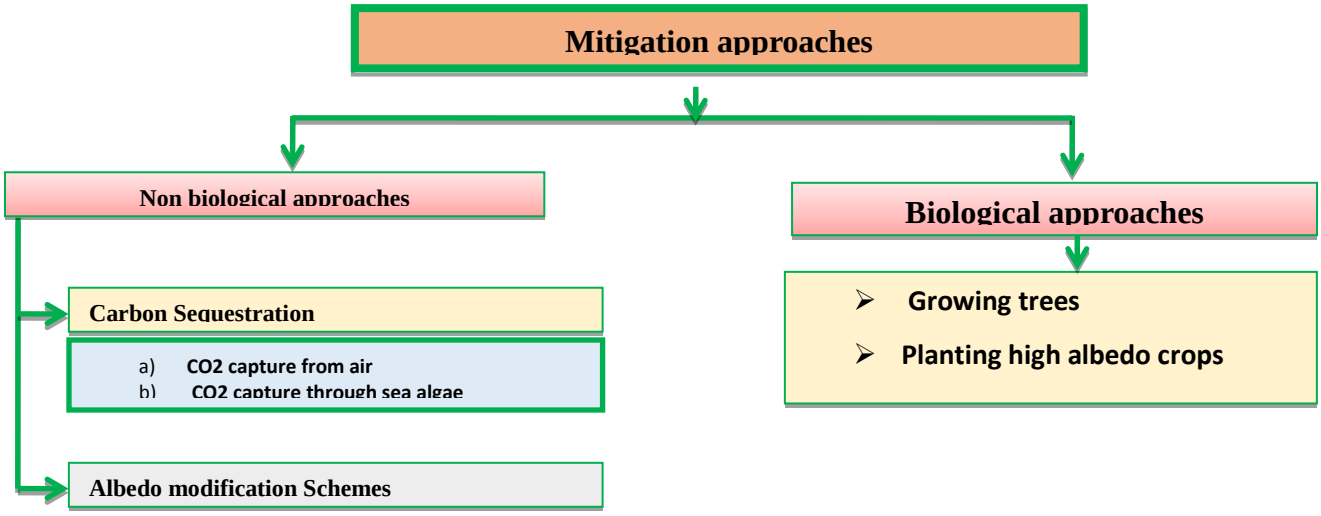
ADAPTATION OF FRUIT CROPS

- Management of plant architecture
- Use of heat shock proteins
- Use of abiotic resistant root stocks
- Use of plastics for crop production
- To use the Agro-Horti cropping system
- Conservation of soil moisture
- Use greenhouse technology if possible
- Use of green biomass for improving micro climate during hot weather.
- Use of shelter belts or wind breaks to overcome the effects of hot wind with reducing the temperature.
- Water use efficiency and irrigation methods *etc*.

MITIGATION APPROACHES

Mitigation measures

- Adopting proper policies and protocols at global, national and state levels.
- Strict adherence to rules and regulations.
- Reducing the rate of global warming by reduced consumption of fossil fuels.
- Use of clean and eco-friendly technologies.
- Promoting carbon sequestering / carbon locking / carbon trading.
- In-situ and Ex-situ biodiversity conservation measures.



- Creating all round public awareness

CLIMATE CHANGE OPPORTUNITIES FOR HORTICULTURE

- Potentially less CO2 needed for glasshouses.
- Earlier and quicker ripening e.g. with a 2°C temperature increase, some apple varieties could bloom and mature up to 3 weeks earlier.
- Possible increase in yields due to more carbon dioxide available for growth and development.
- Some crops will benefit from increasing temperatures e.g. onions, legumes, carrots and sweet corn.
- The crops every year suffer from frost, hail storm *etc* and reduces the growth, yield and quality. But now due to climate change, the frequency and intensity of frost, hail storm will be decrease which will help to improve the yield and quality.

FUTURE THRUST

- ✓ To study and analysis on impact of climate change on fruit crops and its production.
- ✓ To develop climatic models with software which should furnish the information of unfavorable climatic conditions in advance stage or before season.
- ✓ To develop genetically modified varieties/cultivars against climatic abiotic stress.
- ✓ To develop the specific agro techniques for the crops suitable during adverse climatic conditions.

CONCLUSION

Climate systems may change more rapidly than in the past. Global mean temperatures increased by 0.74 ^{0}c during last 100 years. Industrialized countries are more responsible for threat of climate change.There is no doubt that a change in climatic patterns willaffect pollination(Citrus), fruit size, quality(Apple) and yield(Mango) of fruit crops. Changes in temperature and precipitation will influence new disease and pests on fruit crops. By adapting mitigation strategies in order to sustain fruit production under impact of climate change and need more time to become effective.

Effect of Climate Change on Fruit Crops

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The Earth's climate, although relatively stable for the past 10,000 years or so, has always been changing, mainly due to natural causes such as volcanic activity. But since the 1900s more rapid changes have taken place and these are thought to be mainly man-made. Global mean temperatures increased by 0.74 0C during last 100 years and the year 2100 best estimates predict between a 1.8 0C and 4 0C rise in average global temperature, although it could possibly be as high as 6.4 0C.(James and Pender 2008). Climate change is a big threat to human food supply. Around 12% of world's population is already at risk of hunger, but if temperature rises by only 2 to 3°C it will increase the people at risk of hunger, potentially by 30 - 200 million. Once temperatures increase by 3°C, 250 - 550 million additional people may be at risk most in Africa and Asia. (Stern, 2011) Food production will be particularly sensitive to climate change, because crop yields depend directly on climatic conditions (temperature and rainfall patterns) and could lead to food yields being reduced by as much as a third in the tropics and subtropics.(James and Pender 2008)

WHAT IS CLIMATE CHANGE

"Climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC)

CAUSES OF CLIMATE CHANGE

Natural Causes

1) Continental drift
2) Volcanoes
3) The Earth's Tilts
4) Ocean Currents
5) Intensity of Solar Radiation

Anthropogenic Causes

1. Green Houses Gases

a. Carbon dioxide (CO_2)
b. Methane (CH_4)
c. Nitrous oxide (NO_2)
d. Chlorofloro carbons (CFCs)
e. Ozone (O_3)
f. Water Vapors (H_2O)

Land Use Change

a. Deforestation
b. Urbanization

Green house gases

The layer of gases which protects the earth surface from ultra violet rays and other radiation are known as green house gases

Why GHG ?

The optimum layer - warming up the earth surface and atmosphere for sustaining the life at earth.If No GHG - there would be more day-night temperature fluctuation up to minus and living body would not possible at earth surface.Presently - the levels of certain GHG, in the atmosphere are increasing and block thermal radiation emitting from the earth, thereby, increasing the terrestrial temperature.

GREEN HOUSE EFFECT

Radiation reaching the planet is partly absorbed, causing the Earth to emit thermal radiation and part of the radiation is reflected back to the atmosphere. Water vapour and radioactively active CO_2, CH_4, N_2O and O_3 etc. partly trap the reflected radiation to warm the surface temperature, a natural phenomenon known as the **'Greenhouse Effect'.**

The direct effect of this is to warm the earth's surface and troposphere or lower atmosphere. This process is known as green house effects.

Predicted CO_2 concentration

Years	CO_2 conc. (in ppm)
2000	369
2010-2015	388-398
2050-2060	463-623
2100	478-1099

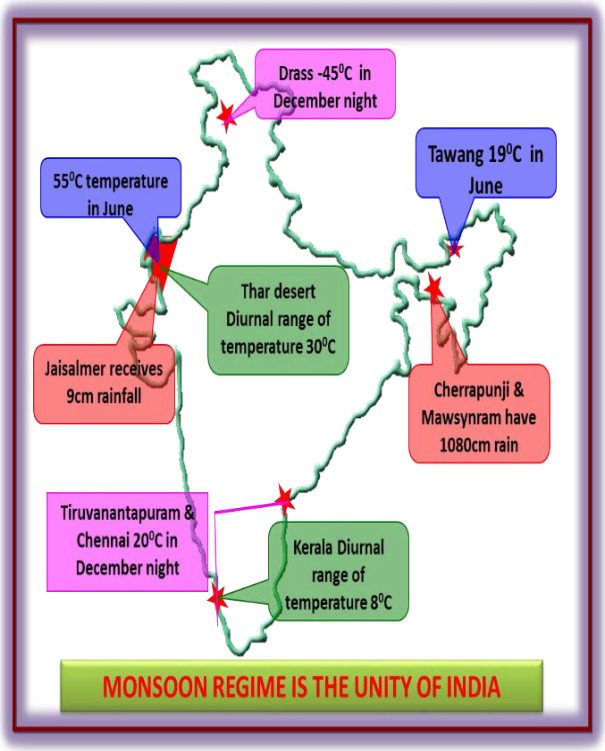
IPCC, (2007)

Impact of climate change on fruit crops

- Low perfect flowers
- Increase the pollination failures
- Increased physiological disorders
- Reduce Colour development in apples
- Early maturity of Citrus, Grapes etc
- Advancement of bud burst in Almond
- Delayed panicle emergence due to low temperature

Climate diversity in India

India have lot of diversity i.e. Regions wise, religious wise, same as in climate also, if we see Indian map we can observe changing of weather at the same time and same season different localities of India. Below this picture depict about climate diversification in India.



Traditional calendar of INDIA

Indian ancient farmers cultivated their crops according to season wise like as*Magh, Falgun* etc. but now a days farmers are confusing cultivating of their crops because of changing of monsoon period as well as spring and summer seasons. In this table show that our seasons and changing pattern of climate.

Indian Horticulture

India accounts for only about 2.4 % of the world's geographical area and 4 % of its water resources, but has to support about 17 % of the world's human population and 15 % of the livestock.

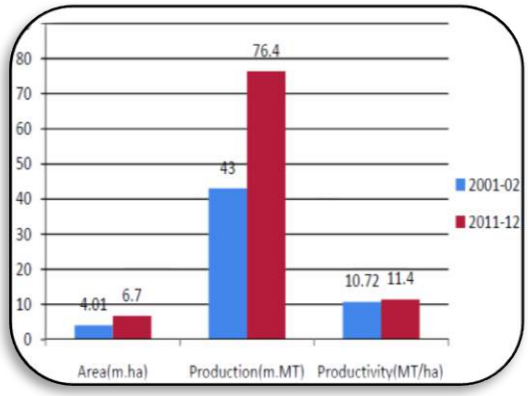
- Population: 1.26 billion (2011)
- % Share of Horti GDP in Agri: 30% (2012)
- Area under Horticulture: 13.08 % (23 mha)
- Area under fruit crops: 6.7 mha
- Population dependent on Agriculture: 65%

Local term	Approximate period	Description(Ideal)	Description (Present)
Magh	Jan 15-feb 15	Cold with snow fall	Some rain and snow
Falgun	Feb 15- Mar 15	Less cold with snow	Rain
Chaitra	Mar 15- Apr 15	Rain, snow rare	Some rain and snow
Baisakh	Apr 15- May 15	No rain, clear skies.	Dry with some rain
Jeth	May 15- Jun 15	Hot(paddy, dal and corn sown)	Dry
Asadh	Jun 15- Jul 15	Hot (Until June 30), pre-monsoon rain	Hot and dry
Sawan	Jul 15- Aug 15	Rain	Hot and rainy
Bhadra	Aug 15- Sep 15	Rain (Until Aug 30, apple harvest), dry	Predominantly rainy season.
Ashwin	Sep 15- Oct 15	Clear (corn, dal harvest; Wheat, Barly sown)	First half rainy and second half dry
Karthik	Oct 15- Nov 15	Mostly clear (paddy harvest), shorter days	Same as ideal
Magsir	Nov 15- Dec 15	Snowfall, drying fir leaves and wood for fuel	Same as ideal
Paush	Dec 15- Jan 15	Maximum cold with snow	Very little snow

Some Indian fruit facts

- ❖ India is second largest producer of fruit crops. Production of fruits 76.4 million tones, it's accounts for about 30 per cent of the total production of horticulture crops.
- ❖ The area under fruit crops during 2011-12 was 6.7 million ha, which is almost 29 per cent of area under horticulture in India.
- ❖ India accounts for 13 percent of the total world production of fruits and leads the world in the production of mango, banana, papaya, sapota, pomegranate, acid lime and aonla.(NHM 2011)

Growth in area, production and productivity of fruit crops



- Increase the pollination failures
- Increased physiological disorders
- Reduce Colour development in apples
- Early maturity of Citrus, Grapes etc
- Advancement of bud burst in Almond
- Delayed panicle emergence due to low temp

Frost /low temperature injury in arid horticultural crops

Impact of climate change on fruit crops

- Low perfect flowers

S.no	Severely affected fruit plant species	Moderately affected	Less affected	Unaffectd
1	Anola (*Embalicaofficinalis*)	Karonda (*C.carandus*)	Kinnow	Date palm (*P.dactylifera)*
2	Gonda (*Cordia sp*.)	Bale (*Aegle marmelos*)	Salvadora sp.	Khejri(*Prosopiscinerari a*)
3	Ber (*Ziziphus*spp)	*Pithcelobiumdul ce*	Sapota	Cactus pear (*O.ficusindica*)
4	Phalsa (*Grewaiasubniaequal is)*	Pomegranate (*P.granatum*)	Mosambi	--
5	Marula nut(*Sclerocaryobirre a*)	Argan (*Arganspinosa)*	Ker (*Capparisdecidua s*)	---
6	Guava (*Psidiumguajava*)	Fig (F.carica)	---	---

Climate change challenges for fruit crops

- ✓ Fruit mineral production and composition could be affected
- ✓ Warmer winters and reduced frosts will weaken vernalisation, potentially reducing yields in some crops
- ✓ for higher yields and canopy cover
- ✓ New pests, diseases and weeds
- ✓ Possible increase in mycotoxin risk due to changes in fungal growth
- ✓ Potentially more inputs (such as water) required

Technology: Tongue Grafting in *Sohiong* (*Prunus nepalensis* Serr.)

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Prunus nepalensis (Rosaceae) is an important indigenous underutilized fruit of the entire northeast India. However, it is considered as one of the important underutilized fruit crops in the hills of Khasi and Jaintia, Meghalaya. The fruit tree is growing wildly in the forest areas and as backyard crop. Since time immemorial, this fruits are being utilized by the tribal in various forms. Fruits are eaten fresh when ripened. The *sohiong* fruit quality is excellence with unique colour, taste and flavor. It is also richer in nutrition. It has a good potential for extraction of natural edible colour required in food industry. It is has also been observed that its colour added to squash and jam may last longer of around one year. RTS and cherry wine are also being prepared from pulp and juice of the fruit due to its imparting purple colour to the wine. The expansion of area for commercial cultivation of this crop in the state may offer generation employment and income generation for the tribal peoples. Furthermore, it is high time to popularize the crop for its proper collection and strategies management techniques for sustainable production and conservation. So far there are very few established orchard of this crop in the region. This is due to non-availability of standardized propagation technique which caused a major hindrance in multiplication and area expansion of *sohiong*. In view of this, a 'Tongue' grafting technique for easy and quick multiplication of *sohiong* was developed at the ICAR Research Complex for NEH Region, Umiam, Meghalaya, India. It was found that plants of *sohiong* obtained through tongue grafting were found to give higher growth characters over seedling plants with respect to all characters with the exception of plant height were maximum was recorded in seedling plant (120.56 cm). Maximum stem diameter (17.47 mm), number of branch (6.72), plant spread in E-W (49.81 cm) and N-S (42.86 cm) was

recorded in grafted plants as compared to seedling plants.

Key words: *Prunus nepalensis* L., Propagation, Tongue grafting

INTRODUCTION

Prunus nepalensis is locally known as *Sohiong*, belongs to family Rosaceae. This crop is an important indigenous underutilized fruit of the entire northeast India. It is widely distributed in different part of the northeastern region, particularly, Khasi and Jaintia Hills of Meghalaya, situated within $25^0$1' and $26^0$5' North latitudes and $85^0$49' and $92^0$52' East Longitudes with altitude ranging from 300 to 2000 m and temperature 2 ^{0}C - 36 ^{0}C. The fruit tree is growing wildly in the forest areas and as backyard crop. So far there are very few established orchard of this crop in the region. *Sohiong* has an immense potential for commercial cultivation in the state as well in other part of the world which is relative cool climate.

Since time immemorial, this fruits are being utilized by the tribal in various forms. Fruits are eaten fresh when ripened. The *sohiong* fruit quality is excellence with unique colour, taste and flavor. It is also richer in nutrition (Rymbai et al., 2014; Deka and Rymbai, 2014). It has a good potential for extraction of natural edible colour required in food industry. It is has also been observed that its colour added to squash and jam may last longer of around one year. RTS and cherry wine are also being prepared from pulp and juice of the fruit due to its imparting purple colour to the wine. The expansion of area for commercial cultivation of this crop in the state may offer generation employment and income generation for the tribal peoples. Furthermore, it is high time to popularize the crop for its proper collection and strategies management techniques for sustainable production and conservation. However, due to non-availability of standardized propagation technique has caused a major hindrance in multiplication and area expansion of *sohiong*. In view of this, the Division of Horticlture, ICAR Research Complex for NEH Region has developed a 'Tongue' grafting technique for easy and quick multiplication of *sohiong* (Patel et al., 2011).

Among different propagation grafting techniques experimented in *sohiong*, it was found that tongue grafting was significantly produced maximum graft takes, growth and development of grafted plants. Tongue grafted plants are stronger, because the interlocking tongues are held under compression by the natural springiness, i.e. elasticity of the wood of both stock and scion. This naturally generates the pressure needed for graft union formation. The additional length of the vascular cambium exposed along the cut surfaces of a tongue graft, original diagonal cut plus tongue cut is much greater than the length of cambium exposed by only the diagonal cut without the tongue. This results in

greater cambial contact between stock and scion of a tongue than of a splice graft.

2. Selection of mother plant

The main objective of mother block is to get healthy scion and making available enough scion sticks. The performance of the progenies depends entirely upon the characteristics of the mother plant. There is great variability in fruit types among different *sohiong* genotypes. Therefore, selection of the elite mother plant must be done with maximum care. The basic characteristics while selecting mother plants must be considered are;

(i) Consistently high performance and yield over several years

(ii) Healthy and free from incidence of diseases and insect pests

(iii) Plants with good quality parameters.

The monitoring and maintenance of these mother blocks should be done regularly so that they remain healthy and free from diseases and insect pests. It must be pruned regularly to maintain them in vegetative phase and to produce enough shoots for propagation. The prune parts should be applied with Bordeaux paste. Periodical removal of criss-cross branches, water sprouts and diseased branches is necessary.

3. Harvesting of ripened fruits

To raise seedling for rootstock, only the well ripened fruit are harvested and collected usually in the month of September – October for seed extraction. The ripened fruits are indicated by fully blackish or purplish coloured and slightly soften when touched. If fruits are not fully ripened, there may be difficulty in removal of pulp, and embryo may not be fully mature to become capable of germinate.

4. Seed extraction

The seed should be extracted from fruit by removing the flesh portion manually. This can be carried out by subjected the fruits to fermentation.

4.1. Fermentation

Fermentation of the fruits are carried out by keeping the collected fruits in a bucket containing water for a period of about 3 – 4 days. The soaking is done for quick fermentation of pulp adhering on seed, thus facilitate easy removal of the stone.

4.2. Pulp removal

Following 3 – 4 days of fermentation, the fruit pulp are removed from the stone by rubbing the fermented fruits between the palm under water or by holding it under water and using a brush, to scrub it clean. Seeds extraction can be also be done by maceration and recovered by flotation. The extracted seeds are washed in water, preferably running water and allow seeds to air dry under shade for 24 hours.

5. Raising of rootstock

5.1. Stratification

The present of dormancy in *sohiong*, prevent its seed from immediate germinate upon sowing. Seed dormancy in *sohiong* may be imposed due to its hard seed coat and

internal regulated by the inner seed tissues. Therefore, *sohiong* seeds require special treatments to overcome dormancy, thereby causing it to be more ready to germinate. The seed required to be subjected to a particular duration of moist-prechilling to break dormancy for germination, this prosess is known as stratification. In stratification, the freshly extracted seed are kept in a closed pot containing alternated layers of moist sand and stored at low temperature, about 4 – 8 °C. Periodically, the medium are monitor that it should be slightly moist but not dry nor wet. The length of time of stratification is about 3 – 4 weeks, indicating by the initiation of seed coat rupturing at 3 weeks.

5.2. Primary nursery

Once the seed has completed stratification, it is ready to start growing and utilized its energy reserves at a rapid rate. The stratified and ruptured seeds can be sown during October – November in either of the following two methods;

5.2.1. Polybag

The ruptured seeds following stratification should be taken out of moist sand and sown during October – November in polybag having thickness of 100 gauge and size of 10 x 15 x 10". The ruptured are sown in polybag containing media of equal amount of soil, sand and FYM mixture. Seed sowing depth is about 5 cm. Following which the polybag are arranged in rows for easy management. Sowing in polybag is preferred over seed bed due to easy removal of seedling while transferred the seedling to secondary nursery. The mortality rate during secondary nursery operation is minimal as the seedling are transplanting along with the earthball.

5.2.2. Seed bed

Sowing of stratified seeds can also be done in nursery bed containing equal amount of soil, sand and FYM mixture. Seed bed must be 1 m width and 10 – 15 cm above ground level. It must be fine tilt and avoid of any soil clotting and stone. Sowing depth is about 5 cm depth. Seed are sown in line at 5 cm between the seeds and 10 cm between the lines. After sowing, the seed beds are covered with straw mulch and irrigate gently. The straw mulch should be immediately removed when the germination has initiated in the bed. During transplanting to secondary nursery, a high mortality (25 - 30%) was recorded in seedling grown in primary seed bed. Therefore, the seedling must be intached with earthball as much as possible during transplanting.

6. Germination

Seeds germination starts at about 30 to 45 days after sowing. The germination percentage in *sohiong* is about 95%. *Sohiong* seed coat is hard; however, it does not required scarification prior to stratification as shown by its high percentage of seed germination. This indicates that seeds of *sohiong* do not have double dormancy.

Germination of seeds can be improved by treatment with GA_3 @ 150-200 ppm or Thio-urea @ 5 g/litre water.

7. Secondary nursery

Seedling after 3 -4 months of sowing attained 15 – 20 cm height. These are transfer to secondary nursery in polybag (10x15x 20 cm) containing equal amount of soil, sand and FYM mixture. While transplanting, the earth ball must be kept intact with the roots to avoid maximum mortality. The seedling must be planted in the middle of the polybag and gently press the soil with fingers. Pressing the soil near the stem of the seedling must be avoided as it caused breakage of the roots due to its brittleness. Following transplanting, light shower irrigation must be given for proper establishment of seedlings.

8. Selection of scion

A scion of about five to six month old shoot should be selected as scion material from healthy mother plants of *sohiong*. Shoot selection should be carried out during September, when the shoots are in dormant stage. The scion stick should be of pencil thickness preferably the same size as the stock and contained with 3 to 4 internodes of 25-30 cm long containing dormant plumb buds should be used for grafting. If the stock is larger than the scion, contact can be made on only one side. The scion should never be larger than the stock. The shoot which has initiates sprouting or shows sign of green tips of buds must be avoided, as there is very low percentage of graft take. Avoid any shoot that is older. Scion stick should be straight and have many vegetative buds. Avoid any wood with spurs containing fruit or blossom. Watersprouts, *i.e.*, excessively vegetative shoots should be avoided. Avoid suckers that arise from the rootstock, below the union. One of the problems with using watersprouts is that the tissue often lacks in stored carbohydrates, which is important in the wound healing and callusing process. Shoot of moderately vigorous rather than vigorous upright sucker wood should be selected. The bud wood should be collected when buds are completely dormant and as late in the dormant season as possible to minimize the length of storage. The scion stick must be not be winter injured and must be free from pest and diseases. Scions should be severed and cut with sharp, clean knives and placed immediately in moistened plastic bags or bucket containing water. It is good practice during the harvesting of scions and the making of grafts to clean the cutting tools regularly. This may be done by flaming or immersing them in a sterilizing solution. Isopropyl (rubbing) alcohol also works well as a sterilant, although it evaporates quite readily. An alternative sterilizing solution may be prepared by mixing one part household bleach with nine parts water by volume. However, this bleach solution can be highly corrosive to certain metals.

9. Storage of Scion stick

The selected scion shoots may be used immediately for grafting after

detached from the mother tree. For best results, harvest only as much scion wood as can be used for grafting during the same day. However, there is a need of storage of scion for long transportation. The scion wood must remain completely dormant, moist and healthy throughout storage. In case of large quantity of scion, all scions must be cut to a uniform length, keep their basal ends together, and tie them in bundles of known quantity (50 scions per bundle). Bundles of scion sticks may be stored in bins of moist sawdust in cold storages or under shade. However, for smaller quantities, scion sticks can be bundled, wrapped in moist newspaper, particularly the base and kept in plastic bags and stored at low temperature under shade. Label the bundles, recording the cultivar, date of harvest, and location of the stick plant. Regular check is required to avoid disease infestation. The cut ends may also be dipped in wax prior to storage to reduce desiccation. The scion sticks should never be stored along with fruits or vegetables because stored fruits and vegetables release ethylene gas. Exposure of Scion sticks to even very low levels of ethylene may cause woody plant buds to abort, kill making the scions useless.

10. Selection of rootstock

Rootstocks are used in orchards for various advantages, especially when site conditions necessitate. The various characteristics of rootstocks that should be considered when making a selection:

1) resistant to present and potential soil pests;

2) suitable for the soil's texture, depth, and fertility;

3) compatible with soil chemistry (pH, salinity, lime content);

4) favored for the anticipated soil water availability, drainage, and irrigation practice;

5) appropriate for the orchard design and layout; and

6) compatible with scion of high yielding and quality fruits

Rootstocks exert tremendous influence on growth of scions. Selection of rootstocks is considered to have influence on the graftage success and proper formation of the union. Therefore, in *sohiong*, a seedling of one year old and pencil thickness (0.5-1.0 cm) should be selected for grafting purpose. The selected rootstocks must be healthy and free from diseases.

11. Grating time

The best time of grafting is second week September to second week of October, when stock and scion are in complete dormant condition.

12. Grafting technique

The selected rootstock and scion must be of equal diameter. There are two methods of grafting adopted successfully in *sohiong*, *viz*., Tongue grafting and Wedge grafting. The following are the steps necessary for tongue grafting in *sohiong*.

12.1. Preparation of stock

12.1.1. *First cut***:** A smooth diagonal slanting cut of 4 -5 cm long is made on

the rootstock at about 15-20 cm above the ground level. The first cut with a single, smooth cut with no waves or whittling is advised. A good quality, very sharp knife is essential.

12.1.2. *Second cut***:** Another downward cut is given starting approximately 2/3rd from the top of the slanting cut and about 2 cm in length. It begins vertically, then gradually becomes nearly parallel to the first cut surface. This form a 'tongue' like structure on the stock. Remove any lateral branches on the stub that might crowd the graft as it begins to grow.

12.2. Preparation of scion

Identical and complementary cuts are made in the lower side (base) of the scion exactly matching the cut given on the rootstock. When the two pieces are laid face to face the joined unit should look straight and identical. Care should be taken to avoid touching the cut surfaces. Avoid splitting the wood and do not loosen the bark.

12.3. **Insertion of the scion**

After the cuts are made on both parts, open the cuts slightly. Push the scion into the stock together tightly enough in such a way that the cut surfaces match as closely as possible. The scion should be preferably the same diameter as the stock and cambial area, *i.e*. area just beneath the bark of both pieces must be aligned for a union to develop. However, if the scion and the stock are not of same size, *i.e.,* scion is smaller, then it is important that the scion be placed over to one side of the rootstock to match the cambiums on one side only, rather than in the center, so that the vascular cambia match up. The lower tip of the scion should not hang over the stock.

In grafting, the vascular cambium of the scion must be aligned with the vascular cambium of rootstock. In woody plants such as *sohiong* the cambium is a very thin like ribbon, of actively dividing cells located immediately beneath the bark. The cambium produces conductive tissue for the actively growing plant. This vascular cambium initiates callus tissue at the graft and bud unions. In addition, they are also known to stimulating tissue growth on the basal ends of vegetative cuttings before they have initiates rooting.

12.4. Wrapping

The union portion should be wrapped and tied properly with the 150-gauge polythene strip to firmly secure the grafts, exclude air and prevent drying. Wrapping should be overlapping between the strips. It should be started from lower portion of graftage and continues upward to avoid entry of water during irrigation or rainy days. Never allow the binding material to girdle the stem.

13. Tag the scions

It is important to put tags on the scions to avoid confusion among various genotypes of *sohiong* fruits.

14. After graft

Following grafting, the grafted plants must be kept under shade and

avoid drying in the sunlight for better success of the grafts.

15. Graft take

About 80% graft success can be achieved through tongue grafting.

16. Aftercare

After care is very important to ensure high successful of graft. During the healing time, generally graft union is healed first and then they will start to grow visibly. This period of complete healing and graft union formation may take for 30-45 days after grafting depending on the type of graft and the weather. If scion buds start to open, it is not guaranteed that the graft is successful. It is not uncommon for buds to sprout to silver tip and even green tip but then die. For instance, even pruned and detached branches will often have buds sprout and open up from the reserve energy that is stored in them. Once the wood has produced about a half inch (1.25 cm) of new growth it is safe to assume the graft will live.

16.1. Irrigation

Initially, watering regularly with fine mist to avoid any dislodging and loosening the graft union. Soil must be just moist but neither too wet and not too dry. During summer when the sunlight is very high, keep the potted grafted trees in the semi shade, otherwise sunlight is beneficial for the growth of any tree.

16.2. Sprout removal

Periodically, it has to be checked for any sprout emerge or leaves growing below the graft union. Any growth/ or buds in the rootstock must be rubbed off that may have pushed leaves. Because if allow growth in the rootstock, the sap will be directed directly into this growth and the scion would dry and no callus formation.

16.3. Remove wrapping strip

Once the graft union are successfully formed, polythene strip are removed after 2-3 months of grafting to prevent strangling and girdling the graft by becoming too tight. The strip can be removed by carefully unwrap the tape or simply cut through the strip lengthwise with the help of sharp knife/blade to release the pressure and leave the severed tape on the branch.

16.4. Transplanting to field

Healthy plants are ready for planting within nine months after graft success.

16.5. Comparison performance of grafted and seedling plants

Plants of *sohiong* obtained through tongue grafting were found to give higher growth characters over seedling plants (Table 1). All characters were recorded maximum in grafted plants including stem diameter (17.47 mm), number of branch (6.72), plant spread in E-W (49.81 cm) and N-S (42.86 cm) with the exception of plant height were maximum was recorded in seedling plant (120.56 cm).

Table 1 Comparison of grafted and seedling plant of s*ohiong* (one years old)

Plant Types	Plant height (cm)	Stem diameter (mm)	Scion diameter (mm)	Number of branch	Plant canopy spread (cm)	
					East-West	North-South
Tongue grafted plant	113.14	17.47	14.17	6.72	49.81	42.86
Seedling plant	120.56	14.27	-	3.21	28.68	28.02

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