Care Givers' Experiences in Families Living with Mentally Ill Patients

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Abstract: *Family members play vital role in care of persons with sick especially with mental illness living in families. Their care is multiple in terms of taking day-to-day care, supervising medications, taking the patient to the hospital and looking after the financial needs as well as to bear with the behavioral disturbances of the patient. Thus, the family caregiver experiences considerable stress and burden, and needs help in coping with it.*

The present study assessed the experiences faced by care givers in care of mentally ill patients living in their families. It is a part of UGC sponsored minor research project. The four rural areas were selected to assess around 100 participants who were taking care of mentally ill persons in their families. The Convenient sampling technique was adopted for selection of samples by making house-to-house visits, interviewing, and assessment of care giving and living conditions in the families. A Semi-Structured questionnaire was used for this study. In the process of development of the tool the investigator reviewed the secondary data on Mental Illness and the validity of the questionnaire was discussed with subject experts from the field of education and health profession and developed the tool.

Major findings were assessed based on the results of the study. According to this research there is mental illness existing in families, most of family members feel that mental illness is a burden, there is negative opinion (stigma) among family members. An unhealthy coping style is likely to adversely affect the care giving function. Hence, it is important to take care of the needs of the family caregivers. The family caregiver has remained as a neglected lot, often ignored by the mental health professionals. This key support system can't be taken as granted and ignored. Further studies required to provide accurate information for assessment and effective care giving strategies to cope their burden and issues in care giving

Key Words: ***Care Giving, Mental Illness, Patients and Family etc.***

Introduction

Family caregivers play a critical role in supporting, infirm and long term care system by providing a significant proportion of the care for ill persons living in the families. With regard to mental health problems in families, especially when a person is living with a serious mental illness, the whole family may be affected. This situation may bring significant levels of stress for the caregiver and can affect their overall quality of life including work, socializing and relationships. Research into the impact of care giving shows that one third to one half of care givers suffer significant psychological distress and experience higher rates of mental ill heath than the general population. Care giver plays multiple roles in care of persons with mental illness, including taking day-to-day care, supervising medications, taking the patient to the hospital and looking after the financial needs. The family caregiver also has to bear with the behavioral disturbances in the patient. Therefore care giving to patients is psycho-social based.

In Indian context

Mental illness is a global public health concern. According World Health Organization estimation, mental disorders constitute 14% of the global burden of disease and the overall prevalence rate of mental disorders in India is 10-12 percent. In addition, the Global Burden of Disease Study 2010 (GBD 2010) stated that major depressive disorder is one of the top five leading causes of Years Lived with Disability (YLD) in India. Being a developing country, in India there are paucity of mental health professionals for instance, psychiatrists <0.5 per 100,000 population. Majority of the population live in rural areas and it was found that about 80% to 90% of the mental disorders were undiagnosed and untreated due to lack of knowledge and negative attitudes toward mental illness. Further, stigma and negative attitudes toward people with mental illness have been observed to be common worldwide among general population

In Indian culture, family is regarded as the most important structure in caring for vulnerable family members including those with mental illness and more than 90% of patients with chronic mental illness live with their families. Families of Indian patients with mental illnesses have always been involved in their care. Such involvement arises both from choice as well as the compulsion of being a part of an inadequately resourced mental health system.

The caregivers not only provide the basic needs of care like long-term assistance of housing and financial aid they also take care of the day-to-day needs of the people with mental illness, monitoring the mental state, identify the early signs of illness, and relapse and deterioration, and help the patient in accessing services. The family caregiver also supervises treatment and provides emotional support to the patient. However, the lack of knowledge and relatively lower mental health literacy pose challenges to family caregivers, mental health patients and service providers. An extensive body of Indian research on caregiver burden in a number of mental illnesses shows that providing care for a relative with mental illness is associated with considerable distress and burden for the family caregiver Subho Chakrabarti, (2016). Nevertheless, the Indian evidence for the efficacy of formal family-based interventions remains inadequate and lacks methodological precision. Finally, day-to-day practice in clinical settings does not seem to have made use of the ample body of research evidence in this area to help families in distress. Interventions are likely to prove to be a greater challenge than for developed nations, because of the scarce resources and a multiplicity of other social, economic, and cultural hurdles in India. It goes without saying that much more research is required in this area before mental health professionals in this country are able to find effective ways to help families cope with the adverse consequences of providing care.

Care Giving Burden

Care giving associated with emotional and cognitive transformations. This experience leads to the physical, psychological and social impact. India, as well as in most of the nonwestern world, and to a lesser extent in other parts of the world, families have been the mainstay of care giving for persons with mental illnesses. Burden of care" is defined as "the presence of problems, difficulties or adverse events which affect the life (lives) of the psychiatric patients' significant others (e.g. members of the household and/or the family)". The concept of 'burden of care' has two distinct components - the objective and the subjective. Objective burden encompasses measurable effects in household disruptions, economic burden, caregivers' loss of work, social, and leisure roles, and time spent negotiating the mental health, medical, social welfare, and sometimes criminal justice systems. In contrast, subjective burden is the caregiver's own perception of the impact of caring. It consists of the negative psychological impact on the caregiver and includes feelings of loss,

depression, anxiety, anger, sorrow, hatred, uncertainty, guilt, shame or embarrassment, all of which result in much distress and suffering.

Family care giving for mental illness needs to be distinguished from the usual caring, which is age and culturally appropriate. Studies have shown the highest negative impact, where a substantial majority (30%-60%) of caregivers suffer significant distress, Barrowclough C (2005). Because of multiple role that care givers need to play in taking care of ill patients, their treatment and other house hold activities may affect adversely and continuous stress may impact on their physical and mental health as well as on their emotional wellbeing.

Knowledge and Attitude on Mental Health/Illness

Families are a primary care giving resource for persons with mental illness, yet they often lack the knowledge and skills needed to assist their relatives. Studies show that families routinely request information on basic facts about mental illness and its treatment, behavior management skills, and the mental health system in order to better cope with their relatives' illness. Shinde, M., and Anjum, S., (2014).

The individuals with mental health problems were experiencing severe and enduring mental health problems as defined by the Scottish Framework for Mental Health Services, Scottish Executive, (1997). Mental illness, despite centuries of learning and the Decade of the Brain', is still perceived as an indulgence, a sign of weakness. Stigma, prejudice, and discrimination are closely related and tightly interwoven social constructs. Stigma, prejudice, and discrimination against those with mental illness cut across all classes and social groups.

Caring for a relative with a mental health problem is not a static process since the needs of the care recipient alter as their condition changes. Being a care giver can raise difficulties in personal issues about duty, responsibility, adequacy and guilt. It's not anomalous to feel ashamed, or hurt, or mortified by a family member whose behaviors can be difficult to understand and deal with. In other ways families commonly report 'stigma by association' resulting in discriminatory and detrimental behaviors towards patients. In some communities stigma coupled with mental illness brings shame to a family and can affect the marriage potential of their relatives, so families keep the illness private and are often unwilling to seek professional help. In some

communities religious and spiritual beliefs are linked to mental illness and in some cases, influence the treatment. Thus, the family caregiver experiences considerable stress and burden, and needs help in coping with it. The present study focuses on the burden experienced by the family caregivers, assessing knowledge and attitude of patients' relatives towards mental illness seems meaningful so that various mental health professional help and intervention programmes could be formulated and organized. This will also help in proper rehabilitation of the patient. Acquiring knowledge and having positive attitude may help family members to understand and provide better care for the ill persons living in their families.

Methods and Tools

The present study assessed the perceived knowledge and attitude of care givers and experiences burden of care faced by them in case of mentally ill patients living in their families. The study was carried out among selected four rural areas of Dakshina Kannada District. Convenient sampling technique was used to select 100 care givers and **Collected** data by making house-to-house visits through interview and among those who were willing to participate in the study. The study criteria included: (i) He/she must be relative of patient (family member) and diagnosed as mentally ill as per ICD-10. (ii) Care giver (respondent) should be above 18 years. (iii) Must be the main caregiver, (iv) caregiver must have taken care of the mentally ill for more than 6 months. A semi-structured questionnaire was used to assess and in the process of development of the tool, the investigator reviewed the secondary data on Mental Illness and the validity of the questionnaire was discussed with subject experts from the field of education and health profession discussed with experts and developed the tool.

The first part of the questionnaire included socio-demographic details of participants. The second part of the questionnaire collected information regarding mental health literacy of the caregivers by using Family living conditions (burden of care, difficulties and adjustment) which consists of 9 items, attitude toward people with mental health problems (12 items), and knowledge on mental health and illness (15 items). Answers were coded on a 5-point scale for attitude (Strongly Agree, Agree Somewhat Agree, Disagree, and Strongly Disagree) and for knowledge 3-point scale (Good, Poor and Average). Investigator visited Taluk Panchayat and local health care centers to seek permission as well as to collect statistical information. Study was assessed by appointed trained field workers. Descriptive statistics were used and results were narrated in the form of tables and graph.

Results

Study shows the socio-demographic attributes of the sample. In keeping with the demographic and economic profile of participants, the sample was predominantly young and most came from low or low average income households. The present study investigated mental health literacy among 100 caregivers of the persons with mental illness, of whom majority of the participants (53%) were aged between 21 and 40 years. The majority of the participants were married (76%) and Hindus (49%). Nearly half (42%) of the participants were illiterates/primary education Almost all participants (95%) of the caregivers were family members. Merely 89% families availed from middle class, poor having low average income.

Table 1: Family Living Conditions in Terms of Demographic Characteristic

Demographic		Burden of Care 100%	Diffi-culties 100%	Adjust-ments 100%	Total 100% (Affected)
Age	21-30	20	12	07	13
	31-40	16	14	07	12.33
	41-50	11	12	09	10.66
	51-60	06	03	04	4.33
Sex	Male	28	18	12	19.33
Female	25	23	15	21	
Education	Illiterates	19	14	08	13.66
	Primary	11	09	06	8.66
	Secondary	08	06	04	6
	Till S.S.L.C (10^{th})	06	04	02	4
	P.U.C	04	02	03	3
	Degree (UG)	02	01	01	1.33
	Higher studies (PG & others)	00	00	00	00
	Technical (IT & others)	03	05	03	3.66
Family	High	03	02	04	3
Income	Average	23	17	10	16.66
	Low	27	22	13	20.66
	Total	**53%**	**41%**	**27%**	**40.33%**

It is obliviously difficult for families to cope with mentally ill patients. It can be physically and emotionally tiring, and can make them feel vulnerable to the opinions and judgments of others. Caregivers who attempt to balance care giving with their other activities, such as work, family, and leisure, may find it difficult to focus on the positive aspects of care giving and often experience more negative reactions, such as an increased sense of burden (Pavalko E, Woodbury W, 2000). The present study portrays the care giving experiences (affect) of care providers. The affect of mentally ill patients living in families divided into three components which consisted of 9 (3 each) items and asked care givers if the questions were Yes or No. The results were described as burden of care in terms of finance, stress, care giving, difficulties in terms of understanding illness, communication, awareness and adjustment in terms of relationship, job, household activities. Detailed results were shown in table no.1 in relation to demographic profile of the care giver. It also describes how socio-economic conditions affected the care giving of mentally ill patients in families.

As per study concerns, overall a little more than half of the care givers 53% felt burden in terms of stress, 41% of them had difficulties in understanding, awareness on mental illness, communicating with them and 27% of them faced adjustmental problems in living with mental patients in their families. Care giving responsibilities can have a negative effect on work roles as caregivers adapt employment obligations to manage and meet care demands as well as to have good relationship with other family members.

Results of the study on family living conditions by family members are categorized in the form of demographic characteristics. Majority of the caregivers were below the age of 21 to 40 years. The responsibility of care giving seems to be more with the younger members in the family constituting wives, siblings, their children and their spouses. Among them affect of mental illness was 25.33% (21-30, 13% and 31-40, 12.33%). Majority of the care givers affected were females 21%, illiterate people 13.66% were more affected than others and family living condition is usually affected mostly due to poor economic condition 20.66% which was proved in this study. Overall 40.33% of family members felt that their family living condition was affected due to mentally ill patients living in their families.

This study revealed psychosocial, emotional, economic, and physical challenges caregivers undergo in caring for their relatives saddled with mental illness.

The findings point out to problems such as: stress, lack of support or social service provision, poverty due to their inability to work full time resulting in financial difficulties, and general societal stigma of living with someone with mental illness. It is very true that mentally ill person's condition is not in normal condition, which affects daily living and also it affects the family atmosphere. Many times family fails to function. There will be family burden and other related issues taking place.

Table 2: Mental Health Knowledge among Family Members of Mentally Ill Persons

Mental Health Knowledge	Good	Poor	Average
Help-seeking	41	37	22
Recognition	41	43	16
Support	38	41	21
Employment	43	41	16
Treatment	60	30	10

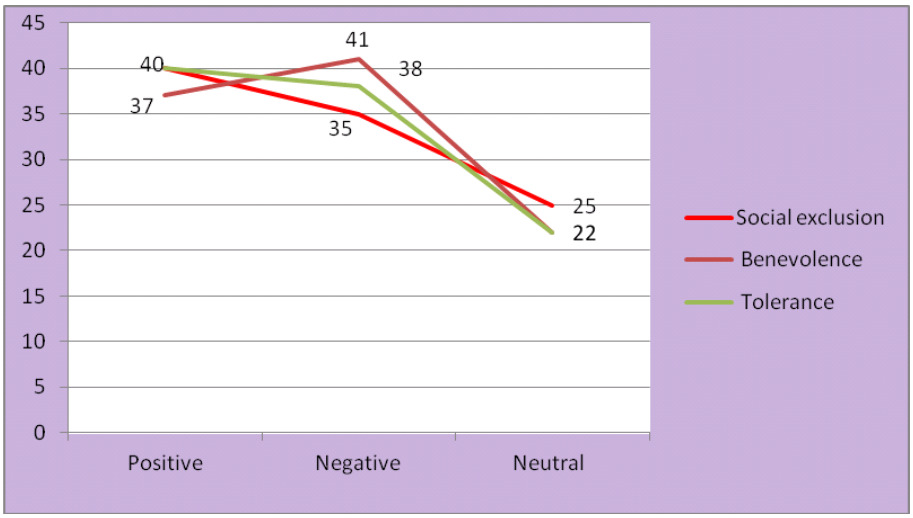
Public stigma against people with mental health problems is damaging to individuals with mental illness and is associated with substantial societal burden. It is a global phenomenon, which is prevalent and persists over time attempted to explore young people's knowledge relating to mental health and mental illness

Study comprised five items covering stigma-related mental health knowledge areas. These statements covered a wide range of issues, including stigma, the likelihood of becoming mentally ill, and the possibility of cure and medical treatment for persons with mental illness. As per table no. 2., describes health seeking aspects in terms of whether they desire to take ill patients to health facilities and opinion towards health professionals where 41% of them had Good, 37% poor and 22% average knowledge. Recognition aspects whether mentally ill patients are needed to be recognized and need to be treated and given well care where 41% good, 43% poor, and 16% average knowledge. In terms of support whether care givers required to support

mentally ill patients around 38% good, 41% poor and 21% average knowledge. Employment related aspects were whether mentally ill patient can be employed 43% good, 41% poor and 16% had average knowledge and treatment of mentally ill patients majority of them i.e., 60% had good, 30% poor and 10% average knowledge among care giver.

Despite the apparent knowledge gap that many have about mental illness. It shows that there was an almost equal percentage (between 38% to 43%) of the family members who had mental health knowledge as well as stigma related mental health knowledge. In terms of treatment aspects majority (60%) of them were in favor of it. Care of mentally ill patients and effective treatment is based on the knowledge acquired by people. Therefore need of awareness among family members of the mentally ill persons is still required.

Figure : Attitude Towards Mental Illness among Family Members



Attitude Towards Mental Illness Among Family Members

Mental illness often constitutes a double jeopardy for those affected because of stigmatization by members of the community (Corrigan and Watson, 2002). An episode of mental distress will disrupt the lives of people so that they are pushed out of the society in which they were fully participating. As per shown in the figure. Respondents were also asked to agree or disagree with a series of attitudinal statements about mental illness. The participants who took part in this study held negative views about the mentally ill. Study assessed three components regarding attitude towards mental illness and mentally ill persons, they are, firstly 'Social Exclusion', or 'Social Marginalization', is the social disadvantage and relegation to the fringe of society. 40% of the family members were in favor of Social Exclusion; 25% of them stood neutral and 35% were not in favor of it. They think that person living in families with mental illness may lose reputation of the family therefore keeping away from family relationships is a better solution. Secondly, 'Benevolence' in terms of helping a mentally ill person seek assistance and treatment as soon as possible will help them and their carer/family deal with the issues they are facing, and ultimately improve their quality of life. The majority i.e., 41% of the family members disagreed to it, they feel that mental illness is untreatable, 37% of them are in favor of it. Thirdly, 'Tolerance' it terms of behavior, care taking, acceptance, treatment and condition of the illness. 38% of them feel that being tolerant is impossible.

Negative views such as those implying on people with mental illness are irresponsible and therefore incapable of making their own decisions, or are dangerous and are to be feared, are widespread. Since negative beliefs often lead to discrimination, there is little wonder that studies have also shown that people with mental health problems living in the community experience rampant harassment (Kelly and McKenna, 1997; Berzins *et al*, 2003). Understanding mental illness and condition of mentally ill patient help care providers to look for healthy care giving strategies which enhance the quality care as well as improve the condition of the mentally ill persons.

Suggestions and Conclusion

Present study has aimed to examine mental health literacy and family conditions among caregivers of people with mental illness. It attempted to investigate the caregivers mental health literacy factors such as etiology, knowledge,

attitude, management, components of attitude on social exclusion, benevolence, tolerance and components on family living conditions such as of people with mental health problems. Study shows that taking care of family member with mental illness is stressful and range of socio-economic factors are responsible for burden in care giving. Family members feel that mental illness is a cause for losing reputation of family therefore it is better that person has to be excluded in all family activities or functions. It shows that participants have negative attitudes towards mentally ill. Study demonstrates that Mental Illness has more negative impact on caregivers. Due to continuous illness, caregivers have to spend more time when their family member is symptomatic as they need to care for their personal hygiene, calm down during emotional outburst and take the brunt of abuse and assaults from their mentally ill family members. Caregivers' involvement in direct and indirect care changes over time, in response to the stage of illness and treatment, and caregivers must be able to adapt to changes in the amount, level and intensity of care demands. Caregivers often take the support of other family members during acute phase in order to deal with the stressful situation of caring mentally ill during symptomatic phase. Care giving for chronically mentally ill family members disrupts the normal functions of families, and it almost always causes stress in the family. There are primary stressors, caused by performing the work required to care for the sick family members, and secondary stressors, problems that emerge in social roles and relationships as a result of care giving. These stressors highlight the fact that care giving work is not only stressful because it requires the performance of difficult physical care and medical care like administering medicines, follow-ups, involvement in productive work and encouraging, but also because of secondary stressors: Marital discord, social isolation, economic strains and family dysfunction. These results have considerable implications for the way in which relatives should be dealt with as part of the overall management of persistent burden of care. It also requires effective coping strategies to take part in treatment and giving care of mentally ill patients.

The caregivers' needs should be understood and addressed. There is a need for developing psychosocial interventions for caregivers in order to address their mental health and their needs. Caregivers needs of caring and concerns of caring should be supported in order to enhance the quality of care and to reduce the burden of caring. Family is a principal source of support and an

important partner in the rehabilitation of the mentally ill. The responsibilities are most often assumed by the immediate family member, carries the heaviest part of the family burden. The caregivers should be acknowledged and looked as resource in the mental health programme. The caregivers should be included, consulted and their voices should be recorded while we draft the mental health policy for the country. The National Mental Health Progamme should incorporate caregivers as resources and initiate programme for enhancing the well being of unheard caregivers. Family based interventions have proven efficacy in reducing relapse rates and negative impact of psychosis on caregivers and can reduce negative attitudes and increase the willingness in the caregivers in providing care to patients. The psycho-education sessions can be given importance which may include a brief introduction to the illness, presenting symptoms, early signs of relapse, available treatments and their efficacy, safety of treatment, common side-effects, treatment related costs, identifying burden, and coping methods. Day-to-day problems in the management of patients should be discussed, and simple and practical solutions may be offered. Simple behavioral interventions like anxiety and stress management may be undertaken. Sessions can be held weekly or fortnightly initially and later once in a month. Number of group members may vary from 10-12 to 15-16. Structured psycho educational interventions consisting of monthly sessions for 9 months have been found to be significantly better than routine out-patient care on several indices, including psychopathology, disability, caregiver-support, and caregiver-satisfaction. There is a need to spread community awareness about the mental illnesses and a message that most of the mental illnesses can be easily treated and the patient can live a nearly normal life in the community. This would help in bringing down the stigma associated with mental illnesses and help integration of persons with mental illnesses in the society, and in turn reduce the stresses faced by the caregivers. There is also need to establish community-based mental health care facilities, which will reduce the distances travelled by patients with mental illness and their caregivers to seek treatment. Long-stay facilities are required for persons with mental illness, who don't have any family members to look after or the family members are not in a position to take care of them due to ill health or old age. At present, treatment of mental illnesses is not covered under medical insurance, which is the need of the hour. Awareness programmes need to be organized regarding provision of disability pension due to mental illnesses. The Government has taken

some steps in these directions under the National Mental Health Program and in the forthcoming Mental Health Care Bill. But still, a lot is need to be done in this direction.

The present study highlighted that almost half of the participants are holding stigmatizing attitudes towards people with mental illness in relation to social participation, treatment, work, marriage and recovery. Most of them face burden in care giving to mentally ill patients and their knowledge towards mental health still has to be enhanced because only they come to know when they go for treatment. Thus, there is an urgent need to educate and change the attitudes of the caregivers regarding mental illness through mental health literacy programs specifically on certain groups within the population who have a particular need for mental health education. Further, mental health professionals should take responsible role in educating these specific populations. Thus, it is necessary to understand the role of caregiver in the recovery process, adequately acknowledged and recognized, often to be reminded so that they would recognize their roles themselves, would act as motivating for them to continue to care their mentally ill family member. There exists a need for developing specific intervention package to empower the caregivers, need to see them as resource rather than just recipients of mental health services.

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India's Co-operative Banks on the Route to Financial Inclusion

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Abstract: *Financial inclusion has increasingly attracted attention of the global community in recent years. The importance of financial inclusion can be explained in terms of maximizing the proportion of population covered by the formal financial sector, to enable the chanelling of funds for productive investment, controlling inflationary tendencies, and monitoring and widening the tax base among other things. This paper looks at the role of the cooperative banking system in promoting financial inclusion. It discusses the genesis of the credit cooperatives supported by the district central cooperative banks (DCCBs) in enabling the provision of financial services to low income families. These institutions are currently the subject of reform programmes intended to make them more efficient and effective as providers of financial services if not necessarily as promoters of inclusion.*

Key Words: *Financial Inclusion, Cooperative Banks, Financial Services.*

1. Introduction:

Financial inclusion has increasingly attracted attention of the global community in recent years. The Blue Book on inclusive finance, a UN publication of 2006, raises the question fundamental to financial inclusion "why are so many bankable people unbanked?" A look at the efforts aimed at financial inclusion worldwide: a Financial Inclusion Task Force and a financial inclusion

fund in the UK, a civil rights law, Community Reinvestment Act (CRA) in the United States, and a host of initiatives like the Committee on Financial Inclusion in India leading to the establishment of a Financial Inclusion Fund – indicates that financial inclusion has been recognized as an issue of central importance in both developed and developing countries.

What is financial inclusion? Put simply, financial inclusion means giving people access to relevant financial services at an affordable rate. The ambit of financial inclusion can differ depending on how policy makers define it. The definition, in turn, depends on the evolution of banking services in a country and the ambition of the policy makers. In a country where a large proportion of the population is unbanked, a characteristic of many developing countries, financial inclusion has a different meaning compared to a developed country where only a small minority does not have a bank account. In the case of the former, opening a basic bank account might amount to financial inclusion whereas in the case of the latter financial inclusion might imply making available a gamut of financial services such as credit, insurance and pension plans

The importance of financial inclusion can be explained in terms of maximizing the proportion of population covered by the formal financial sector, to enable the channeling of funds for productive investment, controlling inflationary tendencies, and monitoring and widening the tax base among other things. The nature of financial exclusion and the reasons for it could vary between countries and within a country but the consequences of such exclusion are uniform.

While financial inclusion may have gained currency internationally in recent times, in India the process of financial inclusion has been on the radar of policy makers for at least four decades. The key mechanisms through which the Government of India has attempted to address the issue of financial inclusion has been through;

1. *Maximizing the spread of the commercial banking system*
2. *The development of the co-operative banking system including primary cooperatives as well as cooperative banks, and*
3. *The creation of an extensive network of Regional Rural Banks (RRBs).*

This paper looks at the role of the cooperative banking system in promoting financial inclusion. It discusses the genesis of the credit cooperatives supported by the district central cooperative banks (DCCBs) in enabling the provision of financial services to low income families. These institutions are currently the subject of reform programmes intended to make them more efficient and effective as providers of financial services if not necessarily as promoters of inclusion.

2. A Huge Effort to Reform the Cooperative System

The performance of the cooperative credit system has been the subject of ongoing debate, not just in recent years, but over many decades. Some of the early efforts to develop and build a strong cooperative credit system have been well summarized in the report of the most recent study group to suggest ways to improve its functioning, the Vaidyanathan Committee of 2004. Within the past ten years, however, there have been three other committees

1. Capoor Committee, 1999: Task Force to study the functioning of the Cooperative Credit System and suggest measures for its strengthening.
2. Vyas Committee, 2001: Expert Committee on Rural Credit.
3. Vikhe Patil Committee, 2001: Joint Committee on Revitalization Support to Cooperative Credit Structure.

The Vaidyanathan Committee documents the deterioration in the functioning of the cooperative credit system, particularly in the 1980s. "The State gave primacy to cooperatives as the sole means of delivering institutional credit to rural areas and injected large and increasing amounts of funds directly. Upper tier cooperative banks were encouraged to accept public deposits and borrow from other financial institutions." The cooperative credit system was also used by the state to channel its development schemes, especially subsidy programmes for the poor. The committee's report notes that "As the financial involvement of the government in cooperatives increased, its interference in all aspects of the functioning of cooperatives also increased…often compelling them to compromise on the usual norms for credit worthiness, [which] ultimately began to affect the quality of the portfolio of cooperatives." In short, the cooperatives "became a conduit for distributing political patronage."

The Vaidyanathan Committee made a comprehensive set of recommendations for the revival of the cooperative credit system. These included;

1. Special financial assistance to wipe out the accumulated losses and to strengthen the capital base of the cooperative credit institution. Responsibility for funding these losses was divided amongst the Government of India (agricultural loans of cooperative banks and all credit businesses of PACS), the state governments (non-credit businesses of PACS, credit guaranteed by them and other receivables from them) and cooperative credit societies and banks themselves (return of state government equity and direct loans made by them voluntarily).

2. Radical changes in the legal framework to empower the Reserve Bank of India – as the banking regulator – to take action directly to ensure the prudent financial management of cooperative banks. This entailed the enactment of legislation at the state level for facilitating an appropriate governance and supervisory structure including provisions to be incorporated in existing Cooperative Societies' Acts to enable this process.

3. Improvement in the quality of personnel at all levels of the cooperative credit system through capacity building and other interventions that would lead to an improvement in efficiency. This would include improvements in efficiency through the establishment of a new and enhanced common accounting system, management information system, internal controls and audit mechanisms, enhanced credit appraisal and risk management, business diversification, product development and HR as well as financial literacy and awareness of rights and responsibilities amongst PACS members.

Thus, the measures recommended required the state governments first to sign up to the Government of India's scheme including legal and regulatory changes to be followed by the enactment or amendment of appropriate legislation. The release of funds to the states for this reform process would then be linked to a number of administrative measures;

3.1 Reconstitution of boards of management, elected with no state government nominees.

3.2 Cooperative banks accept criteria of eligibility for board membership

3.3 Professionally qualified (as prescribed by RBI) persons are appointed as CEOs of banks and properly trained personnel as secretaries of PACS.

3.4 All employees are answerable to the boards of cooperatives and CEOs and staff is appointed by them.

3.5 Boards are limited to policy decisions and reviews while the CEO and staff screen, appraise and decide on loan applications and take actions necessary to ensure recoveries.

3. Will Cooperative Reform Enable Inclusion?

After nearly two years of the reform process for financial cooperatives, one of the key lessons that has emerged is that the lack of a common accounting system and ineffective audit procedures over the years have resulted in a chaotic financial picture. Lacking appropriate accounting for non-performing assets (NPAs), no accounting for depreciation and other similar problems have made it impossible to determine the correct aggregate financial status of the cooperative credit system. In some cases the accounts have been found to be incorrect by as much as 90% of the total size of the balance sheet of a primary cooperative. As a result, the initial focus of the reform programme has been on using the new common accounting system (CAS) to calculate a corrected figure for accumulated losses so that recapitalization can be expedited. It will become easier to determine the true financial position of the DCCBs to facilitate, in turn, their recapitalization.

The use of CAS to calculate the true financial position of PACS clearly has potential to be reasonably accurate and the subsequent recapitalization of the societies is likely to create reasonably clean balance sheets. However, the possibility of this process being seen by some PACS as a "bonanza" to extract extra recapitalization funds on the basis of massaged balance sheets cannot be ruled out. Nevertheless, the reasonably clean balance sheets of most societies resulting from this exercise would (subject to the conditions set out below) provide the PACS and DCCBs with a new opportunity to revitalize and provide their services to members in an effective and efficient manner. If this were to happen, it would encourage the members to make better use of the cooperatives' financial services. In practice, however, this will only happen if a number of conditions are met. These conditions include

3.1 Professional governance free from political partisanship.

3.2 PACS seen as the members' own institutions and not as an extension of the historical system for extending state subsidies.

3.3 Competent financial management undertaken professionally at both the society and DCCB levels.

Here in lies the challenge; in a politically charged environment where public elections are held virtually every year to select representatives for different levels of government – national parliament, state assemblies, local government – the re-activation of the PACS and DCCB governance structures is more

than likely to reinforce considerations of political patronage. Ensuring that such considerations remain subdued and subordinate to the overall goal of cooperative revitalization will take a concerted effort at restraint at all levels of the political system; something that has not been in evidence in recent years.

In a tradition of lack of competence and discipline in financial management combined with rent-seeking by PACS managers, the likelihood of improved management resulting from training alone is not high. However, a focus on rigorous audits and inspection along with repeated efforts at follow up training could start to create some impact in the long run. It is a decadal rather than a short term programme which will work well only in tandem with improved local governance. Small wonder then that the credit-deposit ratios of cooperatives in India are high resulting from the reluctance of their members themselves to trust their savings to such shaky financial management. the credit deposit ratios of DCCBs have actually risen from less than 80% to over 100% during the current decade. Regrettably, it is most likely that the present effort at reviving the cooperatives will see a sharp, but temporary, improvement in the functioning of the cooperative credit system before a gradual decline again sets in. Periodic improvements of this type have become the norm since the creation of the cooperative system in 1904; there is little in the latest programme to give hope of any better results this time around. The only silver lining is that the high economic growth of recent years has provided the central government with more resources to repay the debt it is incurring for this purpose from the international development agencies – the ADB and the World Bank. To the extent that this latest attempt will inject the cooperative credit system with the resources to continue to provide large numbers of people with at least partial financial services – before another capital injection is required – this exercise is worthwhile; that it will provide a major, long-lasting impetus to the process of financial inclusion is unlikely.

Conclusion

It is apparent from the discussion above that the amalgamation and reform process has lost touch with the original objective of promoting cooperative banks as an instrument of financial inclusion. Though that goal is increasingly being force-fed to the banking system as a whole through the mechanism of "no-frills" accounts and implemented through under-paid business correspondents, it is unlikely that this strategy is sustainable. The purpose of this is to assess the recent operational experience of cooperative banks to

determine their contribution to financial inclusion and to document the constraints such banks face in furthering that process. The results of these assessment will throw further light on some of the issues referred to devise a comprehensive set of recommendations on ways in which the co operative banking system can be supported in maximizing its contribution to providing financial services to low income clients.

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Introduction to Elementary Particles

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Abstract: *Dramatic progress has been made in particle physics during the last two decades. A series of important experimental discoveries has firmly established the existence of a sub nuclear world of quarks and leptons. This article gives a basic introduction to elementary particle physics and its latest advancements.*

Key words:*Quarks, Leptons, Feynman Diagram, QED, QCD, Weak Interaction, Higgs Boson, Deep Inelastic Scattering, GUT, String Theory*

1 Introduction

1.1 Fundamental Constituents

Particle physics is concerned with the fundamental constituents of matter and the fundamental forces through which the fundamental

constituents interact among themselves. The very word fundamental needs explanation. When we say a particle is fundamental, in the language of quantum mechanics, it has no spectra. It is important to note that electron is a fundamental particle to the energy scale we have reached so far. It is because, experimentally the transition $e^{-*} \rightarrow e^{-} + \gamma$ has never been seen. So we can safely say, to the energy scale reached so far electron has remained a fundamental particle. Important aspect to be noted here is, if you want to probe a particle, the wave length of the probe has to be of the order of the size of the particle. To probe small distances, we need high energy particle. Till 1900, only two forces were known gravitational and electromagnetic. Atom was thought to be a fundamental particle since there were no probes which could probe inside the atom. But, the Rutherford's scattering experiment (the large back angle scattering of α particles by gold foil) confirmed that atom has a sub structure. Hence, accelerators were developed to probe the ultimate constituents of matter. In the early decades of the 20^{th} century, the particle beam energies reached only a few MeV (10^6 eV), and the resolution was so poor that protons and neutrons were regarded as fundamental particles. In all these experiments, projectiles were accelerated and were to hit the target which was stationary. Now a days, all the accelerators built are colliders (collide two high energy particles head-on, as opposed to firing one particle on a stationary target).

Suppose an incident particle of mass M_A, total momentum P_A and total energy E_A collide with a particle of mass M_B, momentum P_B and energy E_B, for a fixed target machine ($P_B = 0$), the total available energy rises as the square root of the incident energy $E_{FIXED} \approx (2M_B E_A)^{1/2}$, where as for the collider the energy available is $E_{CM}^2 = (E_A + E_B)^2$. Obviously, therefore, the highest possible energies for creating new particles are to be found at colliding-beam accelerators.

1.2 Birth of the Strong Force

Rutherford's scattering experiment established that, an atom has a sub structure that is the nucleus. Nucleus consists of protons and neutrons. But Rutherford's model did not address the question: what holds the nucleus together? After all, the positively charged proton should repel one another. Hence, it must be some other force and named it as strong force or nuclear force. From the nucleon-nucleon scattering experiments and from the study of deuteron it was established that nuclear forces are of short range, spin dependent, charge independent and have saturation property. Hence the fundamental forces rose to three in number.

In 1930, the fourth fundamental force was discovered in nuclear beta decay and was termed as weak interaction. It was found that a free neutron decays to a proton and an electron. But, the beta decay spectrum was continuous. By the conservation of energy and momentum it was clear that if it is a two-body decay then the beta spectrum cannot be continuous. Also, the interaction violated the conservation of energy and angular momentum. To explain the beta decay spectrum Pauli (Wolfgang Pauli, Noble Prize 1945) proposed that there should be a third particle which is spin $\frac{1}{2}$, chargeless massless. It was called as neutrino (ν) (in beta decay it is in fact anti neutrino $\bar{\nu}$).

The advancement in particle physics was in identifying the **conserved quantities** in a physical system which is based on Noether's theorem. According to Noethers theorem, "for every continuous symmetry of the laws of physics, there must exist a conservation law". For every conservation law, there must exist a continuous symmetry. The invariance under time translation leads to conservation of energy and invariance under space translation leads to conservation of linear momentum and invariance under rotation

leads to conservation of angular momentum. Quantum field theory exploits these conservation laws.

1.3 Development of Quantum Field Theory

In the mean time, the quantum field theory (QFT) was developed (Sin-Itiro Tomo Naga, Julian Schwinger and Richard P. Feynman, Noble Prize 1965). According to QFT, i) all forces are of exchange type, i.e., particle interact through the exchange of a mediating particle which are virtual particles (for a real particle $E^2 - P^2C^2 = M_0^2C^4$, for a virtual particle it can take any value, in other words virtual particle exists for a time allowed by the uncertainty principle). This was a revolutionary concept, since in classical physics, no mediating particles are present. ii) The range of the interaction is inversely proportional to the mass of the particle being exchanged. In electrodynamics, the electromagnetic force has infinite range and hence is mediated by a massless particle which is the photon.
Yukawa (Hideki Yukawa, Noble Prize 1949) applied the QFT to the strong interaction. Since the range of the strong interaction was known, Yukawa predicted the mass of the mediating particle to be around 140 MeV. In the mean time, Powell (Cecil Frank Powell, Noble Prize 1950) and his workers discovered that there are actually three middle weight particles in cosmic rays, which were named as π (pion). It had the mass as predicted by Yukawa. Hence, QFT had its biggest success. Now we know that all the forces of nature (strong, electromagnetic and weak) are governed by the application of QFT.

In 1936, the positron (e^+) the anti-particle of e^- was discovered by C.D. Anderson (Carl Anderson, Noble Prize 1936). Anderson took the photograph of the track left in a cloud chamber by a cosmic ray particle. The chamber was placed in a magnetic field. From the

curvature of the track and from its texture, Anderson showed that the mass of the particle was close to the mass of the electron. In 1960's most of the elementary particles were discovered in the following manner. When a high energy particle passes through matter they ionise the atoms along their path. The ions act as 'seeds' in the formation of a droplet (cloud chamber) or bubble (bubble chamber) or sparks (spark chamber). For example, in bubble chamber neutral particles will be 'invisible', their paths have to be reconstructed by analysing the tracks of the charged particles in the picture and invoking conservation of energy and momentum at each vertex. In a magnetic field, a particle of charge q and momentum p will move in a circle of radius R given by the cyclotron formula R= (pv/qB). Knowing the curvature and the track in a known B, the particle momentum can be measured. The sign of the charge is inferred from the direction of the curve.

The concept of anti particles was introduced by Dirac (Paul Anderson Dirac, Nobel Prize 1933) in his theory to explain the negative energy solution of a relativistic spin $\frac{1}{2}$ particle. According to QFT, for every particle there must be an anti-particle with the same mass, life time and spin but with opposite electric charge and opposite magnetic moment. The negatively charged anti proton was observed at Berkeley Bevatron in 1955 by Segre and his collaborators (Emilio Gino Segre and Owen Chamberlain, Noble Prize, 1959). The neutral anti neutron was discovered a year later. Several more particles were discovered. Some of them were produced in strong interaction but decayed via weak interaction (decaying only after a considerable time) and such particles were termed as strange particles (were produced in pairs). In 1947, G.D. Rochester and C.C. Butler obtained a cloud chamber picture of cosmic rays that indicated existence of a new particle. 'V' track was seen indicating that a new neutral particle had decayed into two charged particles. In cloud chamber, bubble chamber and emulsion chamber, such par-

Table 1: The Properties of the Four Forces

Force	**Srength**	**Range**	**Theory**	**Mediating Particle**	**Life Time (τ)in Sec.**
Strong	1	$10^{-13}cm$	Yukawa theory	$\pi^{\pm}, \pi^{0}$ (spin 0)	10^{-23}
Electro mag-netic	10^{-2}	∞	Quantum Electro-dynam-ics	Photon(spin 1 massless)	Infinite
Weak	10^{-7}	$10^{-16}cm$	Fermi theory	Not known	Unknown
Gravi-tation	10^{-39}	∞	General theory	Graviton (spin 2)	Unknown

ticles were discovered at a faster rate. It was clear by 1960, that there are four fundamental forces. The decay of unstable particles through strong, electromagnetic and weak was established (the uncertainty principle relates the life time and the uncertainty in the energy of a state). An unstable particle does not have a unique mass, but a distribution width $\Gamma' = h/\tau$. So, when τ is very short, its value can be inferred from the measured width Γ'. The quantum electrodynamics (QED) was recognised as the theory of electromagnetic interaction. The properties of the four forces around 1960 are listed below.

By 1960, there were many more elementary particles. The question was whether all these particles can be termed elementary or fundamental particles? Table 1 lists the fundamental interactions as we understand today.

1.4 Production and Detection of Elementary Particles

Most of the elementary particles were produced in cosmic rays, nuclear reactors and particle accelerators. Electrons are produced by simply heating up a metal piece. Protons are produced by ionizing the hydrogen atom. The electrons and protons are stable particles. More exotic particles were discovered in cosmic rays which are high energy particles which constantly bombarded earth from outer space and their origin still remains a mystery. When high energy particles hit the atoms in upper atmosphere they produce showers of secondary particles (mostly muons when they reach the ground). The nuclear reactors are another source of elementary particles. When a radioactive nucleus disintegrates, it emits variety of particles - such as neutrons and neutrinos and alpha particles (bound state of two protons and two neutrons), beta rays (electrons or positrons) and gamma rays (photons). In present day accelerators, electrons or protons are accelerated to very high energy and smash them to a target, using electric fields to accelerate particles, magnetic fields to steer and focus the beams. Three major types of accelerators are 1) linear accelerators, 2) cyclotrons and 3) synchrotrons. The increasing energy requires increasing sophistication of tools to detect particles.

In modern accelerators, it is possible to generate intense secondary beams of positrons, muons, pions, kaons and antiprotons which can be fired at another target. The stable particles such as electrons, positrons and antiprotons can be fed into giant storage rings which

guided by the powerful magnets circulate at high speed and can be used at the required moment. It should be noted that the heavier the particle to be produced the higher must be the energy of the collision. Hence, the light particles are produced first. In general, higher the energy of the particle (hence higher is the momenta) the smaller is the wave length and hence can probe a smaller distance. Hence, to probe a small distance higher energies are required. The accelerator at CERN (European Organisation for Nuclear research), is the large hadron collider (LHC) collides proton on protons each of 7 TeV to produce centre of mass energy of 14 TeV. Two protons colliding at high energy can produce various hadrons plus very high mass particles such as z bosons. The Higgs boson was discovered in LHC. LHC is the largest and highest particle collider with CM energy of 14 TeV. Its length is 27 km in circumference and it is 175 meters beneath the ground. The other important collider is the relativistic heavy ion collider (RHIC) at Brookhaven National Laboratory (BNL), Upton, New York, USA. In RHIC, two gold nuclei of 200 GeV collide to produce centre of mass energy of 400 GeV. Its length is 2.4 miles and temperature achieved is about 10^{12} K (for detecting quark-gluon plasma, believed to be formed during the big bang). RHIC collisions occur thousands of times per second. The high energy accelerators developed in last twenty five years are listed below.

1) LEP-I e^+e^- collider, CERN 91 GeV (1989 1994)
2) LEP-II e^+e^- collider, CERN 209 GeV (1995 2000)
3) HERA-I ep (electron-proton collider), DESY 27 + 800 GeV (1992 2000)
4) HERA-II ep collider, DESY 27 + 920 GeV (2002 2007)
5) TeVatron Run I ppbar collider, (proton-anti proton) Fermilab 1.8 TeV(1987 -1996)
6) TeVatron Run II ppbar collider, Fermilab 1.96 TeV (2002 2011)
7) LHC, phase I pp collider, CERN 7 TeV (2010- 2012)

8) LHC, phase II pp collider, CERN 14 TeV (2014 onwards)

The early particle detectors were Geiger counters, cloud chambers, bubble chambers, spark chambers, photographic emulsions, Cerenkov counters, scintillators, photo multipliers etc. The present day modern detectors have whole array of these devices connected to a computer that tracks the particles and displays the trajectories on the computer screen. The most of the detectors rely on the fact that when a high energy charged particles pass through matter they ionize atoms along their path. The ion then acts as 'seeds' in the formation of droplets (cloud chamber) or bubbles (bubble chamber) or sparks (spark chamber). It should be noted that neutral particles do not cause ionization and leaves no track. These detectors were placed in magnetic field. From the curvature of the track in a known magnetic field, particle momentum can be measured and from the direction of the curve the sign of the particle can be determined.

1.5 Classification of Elementary Particles (1960)

All the known elementary particles were classified as hadrons (heavy) and leptons (light) depending on their mass. But, now this nomenclature has lost its meaning. After the discovery of the τ^- particle (Mass 1777 MeV) and its corresponding neutrino ν_τ ($m_{\nu_\tau} \leq$ 18 MeV) (discovered by Martin Perl and Frederick Reines (Noble Prize 1995)). The earlier classification still holds but with a definition that hadrons under go all interactions (strong, electromagnetic and weak) where as leptons undergo only electromagnetic and weak interaction. The hadrons were classified into baryons (odd integral spin particles) and mesons (integral spin particles) based on the statistics. Baryons obey Fermi-Dirac (FD) statistics and mesons obey Bose-Einstein (BE) statistics. The complete list of leptons is given in table 3.

2 Quark Model (1964)

2.1 SU(3) Symmetry

With the growing number of strongly interacting particles, it was difficult to believe that they are all fundamental building blocks of nature, and so there were attempts to look for symmetries. Finally, in 1961 M. Gell-Mann and Y Ne'eman proposed the eight-fold way, an SU(3) symmetry scheme for the classification of hadrons, the baryons and mesons. The eightfold way arranged the baryons and mesons into weird geometrical patterns, according to their charge and strangeness. It was found that all observed baryons fall into the representations 1,8 and 10 of the group SU(3) of transformations whereas all mesons are grouped into the representations 1 and 8 of SU(3) (SU(3) is a Lie Group which consists of 3x3 unitary matrices with determinant = +1). This observation served as a basis for the quark model, which was independently suggested by M. Gell-Mann and G. Zweig in 1964. According to the quark model, baryons are made of three quarks up (u), down (d) and strange (s). While mesons are bound state of quark-anti-quark. Quarks are spin $\frac{1}{2}$ particles and so obey Fermi-Dirac statistics. All the quarks carry addition quantum number known as baryon number whose value is 1/3. The three quarks u, d and s form the fundamental representation of the SU(3) group. With this classification all the observed baryons and mesons of same spin and parity form the higher dimensional representations of the SU(3) group. All observed baryons ($J^p = 1/2^+$) are of octet representation and baryons of $J^p = 3/2^+$ form the 10 dimensional representation of the SU(3) group. Out of the 10 ($J^p = 3/2^+$) baryons predicted by the quark model only nine were known experimentally at that time. The greatest triumph of the quark model was the 10th baryons predicted by the quark model (the famous omega particle (Ω^-) with a mass of 1672 MeV and charge -1 with three s quark content) was experimentally

found (V.E.Barnes et al., Phys. Rev.Lett. 12, 204 (1964)) precisely as predicted by Gell-Mann (Noble prize for Gell-Mann in 1969) (appendix I). Also, the quark model could successfully account for the masses, magnetic moments, and lifetime and could predict the principal decays of hadrons. One of the biggest successes of the quark model was its prediction of the neutron magnetic moment (which could not be explained in nuclear physics since the charge of the neutron is zero). The quark model was accepted by the scientific community partially. The rest mass of an individual quark is not well-defined, given that individual quarks don't exist. The proton and neutron have masses $\approx$ 1836 times that of the electron,but this doesn't mean that up and down quarks have masses of roughly one-third of the proton. The strong force is so powerful inside a triplet that the energy which binds them together (think of it as "strong-force potential energy", analogous to gravitational potential energy) is by far the largest contributor to the mass of the proton. That is, the quarks potential energy far exceeds the energy $E = mc^2$ that their masses represent, so the mass of a proton may consist of $5\% - 20\%$ quark mass (it's hard to tell), and the rest is the nuclear binding energy.

2.2 Introduction of the Colour

In spite of great success of the quark model, it had one very big draw back. It violates Paulis exclusion principle. Since quarks are fermions the wave function of the baryon has to be antisymmetric. But the Δ^{++} particle (and also the Δ^{--} and the Ω^{-}) total wave function turns out to be symmetric. Hence, there was a danger of quark model being abandoned. To save the Pauli Exclusion Principle, O.W. Greenberg (O.W. Greenberg, Phys. Rev.Lett. **13**, 598 (1964)) proposed that each flavour quark comes in three colours, red, green and blue. Baryon wave functions are products of a symmetric space-spin-flavour wave function, and an antisymmet-

ric colour wave function. Hence the total wave function is antisymmetric. It is to be noted that the term colour here has absolutely no connection with the ordinary meaning of the word. Redness, blueness and greenness are simply additional quantum numbers used to denote quarks in addition to the charge and the strangeness. With the introduction of the colour, quark model was saved. Since it was clear that none of the baryons or mesons are fundamental particles, attempts were made to explain the baryon and meson spectra from the quark models. That is to describe the excited states which one observes when protons or neutrons are bombarded with particles having energies higher than several hundred MeV. Under such circumstances the nucleon can assume different properties that can be described as an excitation of the nucleon, analogous to the excitation of atoms or nuclei. Many excited states of the nucleon have been discovered. The nucleon is merely the ground state of a complex spectrum. Since all baryons levels have half-integral spin, any such transition requires an integer change of angular momentum. Consequently, the system that is emitted or absorbed by the baryon during such a transition can consist of any number of bosons, or of an even number of fermions, or of both. As in atoms and nuclei, one observes the emission and absorption of photons in transition between baryon sates. These occur only between states of the same strangeness, and this tells us that there is a selection rule $\Delta S = 0$ for electromagnetic transactions. In baryon transition, yet another transition mode appeared: the absorption or emission of particles belonging to a new species, the mesons. As mesons can be absorbed or emitted singly, it is clear that mesons are bosons. The characteristic energy differences are of the order of several hundred MeV (for recent excited states of hadrons see Particle data group (2016). The baryon spectrum is the third level at which nature offers us a series of well defined quantum states: the first were the atomic and molecular spectra, the second the nuclear spectra. The typical

excitation energies are higher with each step: of the order of eV in the first, MeV in the second, and GeV in the third. In an analogous manner, the π's are the lowest-lying members of the meson spectrum. Each of the meson octet's have a rich spectra. All these mesons are interconnected by some combinations of strong, electromagnetic, or weak decays, and can be viewed as the excitation of a single system, the meson. The Table 4 lists the mediating particles of the strong, electromagnetic and weak interactions. Table 5 lists the conservation laws for strong, electromagnetic and weak interactions.
But, it should be noted that all naturally occurring particles (baryons and mesons) are colourless. The colourless means that the total amount of each colour is zero or all three colours are present in equal amounts. The only colourless combinations you can make are $q\bar{q}$ (the mesons), qqq (the baryons) and $\bar{q}\bar{q}\bar{q}$ (the antibaryons).

2.3 Evidence of Quarks, Deep Inelastic Scattering (DIS) Experiments

The quark model suffered from one profound embarrassment. In spite of the most diligent search over the years, no one has ever seen an individual quark. Now, if a proton is really made out of three quarks, the quarks should come out when hit by a projectile of sufficient energy. Also, one of the quarks should be absolutely stable. Since it can not decay into any lighter particle of fractional charge.

Though no free quarks were seen, one can probe inside the proton in much the same way as Rutherford probed inside of an atom. Sixty years later, history repeated itself when a SLAC (Stanford Linear Accelerator Centre) team of scientists performed (Breiden bach et al., Phys. Rev.Lett.23, 935, (1969)) inelastic electron-

proton scattering with incident electron energies between 7 GeV to 17 GeV. In the reaction e + p $\longrightarrow$ e'+ X, they only counted the number of outgoing electrons at various angles, leaving the debris X unobserved. Such cross-sections are termed 'inclusive' cross sections. The results of these experiments are called 'deep inelastic scattering (DIS)' experiments. When the momentum transfer is much larger than the average internal momentum of the nucleon in the ground state, the process is referred to as DIS. In a DIS process, large amount of energy and momentum is transferred to the target. The results of the DIS experiments were striking similar to the Rutherfords scatter results of the DIS experiments were striking similar to the Rutherford's scattering experiment. Most of the incident particles pass right through, whereas a small number bounces back sharply. This means that the charge of the proton is concentrated in small lumps, just as Rutherfords results indicated that the positive charge in an atom is concentrated at the nucleus. However, in the case of the proton the evidence suggests three lumps, instead of one. This is a strong support for the quark model. The Nobel prize was awarded to Jerome.I. Friedman, Henry W. Kendall and Richard E. Taylor for their pioneering work on DIS experiments.

3 Quantum Chromo Dynamics (QCD)

3.1 The Theory of Strong Interactions

The experimental confirmation that quarks come in three colours came from the ratio of the cross sections of the process of $e^+ + e^-$ hadrons to $\longrightarrow$ $\mu^+ + \mu^-$. Also, in the e^+e^- collider as beam energy was cranked up one encountered a succession of such thresholds. First the muon and the light quarks, later (at about 1500 MeV) the charm quark, was found. C.C Ting in the summer of 1974 at

SLAC found an electrically neutral, extremely heavy meson more than three times the mass of the proton. It had an extraordinary long life time (10^{-20} seconds). The new particle was named $\mathbf{J/\Psi}$ (Samuel C.C. Ting and Burton Richter Noble Prize, 1976) which has a mass of 3097 MeV with a charge 0 and the quark content ($c\bar{c}$) (Charmonium is the bound state of charm quark and anti-charm quark) and subsequently another new meson known as upsilon (γ) (Bottomonium is the bound state of bottom quark and anti-bottom quark) was discovered (Herb et al., Phys. Rev. Lett.39, 252 (1977)) and it was quickly recognized as the carrier of a fifth quark, b (for bottom). The $\gamma(b\bar{b}$) has a mass of 9.460 GeV. Many more charmed and bottom baryons and mesons were discovered which led to the study of heavy quark spectroscopy. One more quark named top quark, the sixth member was observed in 1995, almost 20 years after the discovery in 1977 of the previously heaviest quark, the bottom quark. The top quark (t) has a mass of 175 GeV. It was discovered at the Fermi lab in proton- anti proton collider with 1.8 GeV center of mass energy. The system is so short-lived that no discrete bound states have been found so far. Table 2 gives the complete list of quarks.

The nuclear force is also taken into account by QCD. At distances large compared to the size of hadrons there is no strong force between hadrons, since they are colour neutral. The nucleon-nucleon interaction is described by the exchange of and mesons when the two nucleons do not over lap. But, the region where the two nucleons overlap (around 0.5 Fermi) is described by the six quark system and the quark models have been reasonably successful in explaining the short range repulsion.

With these developments QCD was developed. The QCD is the formal theory of the strong colour interactions between the quarks. The quarks which come in 3 colours form the fundamental representation of the SU(3) colour group. The SU(3) group is an infinite

set of 3x3 unitary matrices with determinant +1. The SU(3) group has 8 generators. The anti-quarks carry anticolours. The quarks interact via exchange of gluons. The gluons are the mediators of the quark interaction. The colour charge of the strong interactions is analogous to the electric charge in electromagnetic interactions. A gluon is a very complicated thing. It has no rest mass, and so moves at the speed of light, yet the strong force is still very short-ranged. The reason is, the gluon itself carries strong charge, and thus it can interact with itself! This would be equivalent to the photon carrying electric charge instead of being neutral (except that the strong force is always attractive, never repulsive). Rather than just streaming away from a light source, electrically charged photons would tend to electro statically pull themselves back together. So the gluon has a very limited range, despite being massless. Both forces are mediated by a massless vector particle (a gluon or a photon). But, in QCD there are six types of charges (colour and anticolour) and a charged (i.e. coloured) mediating gluon. Also the gluons interact among themselves to form glue balls. Gluons have a combination of a color and an anti color of a different kind of a superposition of states which are equivalent to the Gell-Mann matrices. Unlike the single photon of QED or the three mediating particle of the weak interaction (W^+, W^- and Z^0) bosons, there are evidently eight kinds of gluons in QCD listed as follows:

$$R\bar{B}, R\bar{G}, G\bar{R}, G\bar{B}, B\bar{R}, B\bar{G}, \frac{(R\bar{R} - G\bar{G})}{\sqrt{2}} , \frac{(R\bar{R} - G\bar{G} - 2B\bar{B})}{\sqrt{6}}$$

In other words, gluons belong to a SU(3) octet. The remaining combination, the SU(3) color singlet,

$$\frac{(R\bar{R} + G\bar{G} + B\bar{B})}{\sqrt{3}}$$

does not take part in the interaction and is a color single and if it exists as a mediator, it should also occur as a free particle and hence

could be exchanged between color singlets (say between mesons or a proton and a neutron) giving rise to a long range force with a strong coupling, but the strong force is of short range. Since gluons are massless, like photons they should mediate a force which is of long range. However, confinement and absence of single gluon, makes strong force short range. In language of group theory, the symmetry of QCD is not U(3), since it requires 9 gluons. But, the experiments resolve the question in favour of SU(3) symmetry.
The equation for QCD is known as Yang-Mills equation which is a coupled partial differential equation. To this day, there is no analytical solution to the Yang-Mills equation. Hence, QCD is the least understood of the three forces. The current topic of interest in low energy QCD is the chiral perturbation theory. Chiral symmetry is the symmetry of the massless fermions. Chiral symmetry is employed to predict the masses of hadrons in the low energy sector. Another field of current interest is heavy-quark spectroscopy.

3.2 Experimental Evidence of Gluons

In the process $e^+ + e^- \longrightarrow \gamma \longrightarrow q\bar{q} \longrightarrow$ hadrons, for a brief moment the quarks fly apart as free particles, but when they reach a separation distance of around 10^{-15} meters (the diameter of the hadron), their strong interaction is so great that new quark-antiquark pairs are produced mainly by the gluons. These quarks and antiquarks join together to make the baryons that are actually recorded at the detector. In all the debris there is one unmistakable footprint left behind by the original quark-antiquark pair: the hadrons emerge in two back-to-back 'jets', one along the direction of the primordial quark, the other marking the direction of the antiquark. But, in addition to two jet events three jet events are also observed, indicating that a gluon carry a substantial fraction of the total energy. The observation of the three-jet event is generally regarded as the most direct evidence for the existence of the gluons.

3.3 Two Important Features of the QCD

The two important features of the QCD are the asymptotic freedom and the infrared slavery. From DIS experiments it was clear that interaction strength between quarks given by the strong coupling constant (α_s) decreases at very large momentum transfers or at short distances. This is termed in literature as asymptotic freedom but at large distances or at low momentum transfers the coupling constant α_s grows in strength and is so large that no free quarks have ever been seen outside the hadron, this is termed as infrared slavery. But, this is the region which is of importance in nuclear physics where quarks condensate to form baryons and mesons. Hence, in quark models, the confinement is imposed by a linear or quadratic potential. Attempts have been made to solve Yang-Mills equation using numerical techniques (known as lattice gauge theories). It is important to note that α_s is in fact not a constant at all, but depends on the separation distance between the interacting particles (hence is termed as running coupling constant). The perturbative analysis of QCD is well grounded based on the fact that the theory is asymptotically free. The coupling constant which is a measure of the effectiveness of the strong force that holds quarks and gluons together into composite particles introduces a dependence on the absolute scale, implying more radiations at low scales than at high ones and it is usually referred to as running coupling constant. The running is logarithmic with energy is given by,

$$\alpha_s(Q^2) = \frac{\alpha_s(\mu^2)}{1 + \alpha_s(\mu^2)\beta_0 \; ln\frac{Q^2}{\mu^2} + 0(\alpha_s^2)}$$

Numerically, the value of the strong coupling constant is specified by two parameters, the renormalization scale (μ) and the corresponding value of the coupling at that point. These two parameters can be replaced by a single parameter Λ so that the running cou-

pling can be expressed as

$$\alpha_s(Q^2) = \frac{1}{\beta_0 \; ln\frac{Q^2}{\Lambda^2}}$$

The coupling would clearly diverge at the scale Λ, called the Landau pole, which specifies the energy scale at which the perturbative coupling constant would become infinite. Its value is experimentally found to be $\Lambda \approx 200$ MeV. This implies that the perturbative calculations are allowed only at energy scales of or higher than one GeV.

Qualitatively we do understand the reason for asymptotic freedom. According to QFT, for example in QED, an electron is just not an electron: it can suddenly emit a photon or it can emit a photon that subsequently annihilates into an electron-positron pair, and so on. Since the original electron is surrounded by e^-e^+ pairs and, because opposite charges attract, the positrons will be preferentially closer to the electron. Therefore, the electron is surrounded by a cloud of charges which is polarized in such a way that the positive charges are closer to the electron. The negative charge of the electron is thus screened. Hence, if we want to determine the charge of the electron by measuring the Coulomb force experienced by a test charge, the result depends on where we place the test charge: when moving the test charge closer to the electron, we penetrate the cloud of positrons that screens the electron's charge. Therefore, the closer one approaches the electron, the larger is the charge one measures. Hence the coupling constant (α) in QED increases at short distances or at large momentum transfers, but decreases at low momentum transfers. If the same analogy is carried to QCD, it is the colour screening of the quark charge. But, there is a basic difference here. The gluons, themselves are carriers of colour, also spread out the effective colour charge of the quark. A red charge is preferentially surrounded by other red charges. By moving the test probe closer to the original red quark, the probe penetrates a

Table 2: Comparison of QED and QCD

S.N.	QED	QCD
1	It is an abelian Gauge theory.	Non-abelian Gauge theory.
2	Mediated by photon which is massless spin 1 particle which carries no electric charge	Mediated by 8 gluons which is a massless spin 1 particle which carries colour charge.
3	The QED coupling constant due to radiative corrections (α) (emission and absorption of virtual photons)increases at short distance but decreases at large distances.	The QCD coupling constant due to radiative corrections (α_s) (emission and absorption of virtual gluons) decreases at short distance but increases at large distances.

sphere of predominantly red charge and the amount of red charge measured decreases. This in literature is termed as "anti screening" of the red colour and is referred to as asymptotic freedom. Below we compare QED and QCD. QED is the synthesis of quantum theory, electrodynamics and relativity. The fundamental constants representing these theories are , e and c respectively. In QED they come together as the fine structure constant $\alpha = (e^2/\hbar c) = 1/137$.

4 Gauge Theories

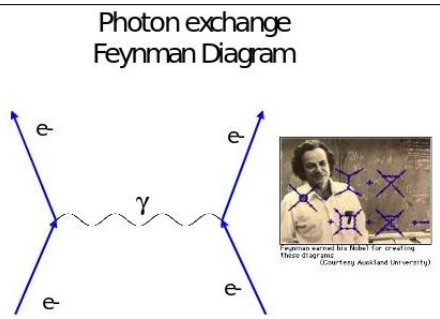
4.1 Theory of Strong, Electromagnetic and Weak.

It is now clear that gauge theories are the underlying theories of the strong, electromagnetic and weak interactions. The basic postulate of gauge theories is that it is not possible to measure the absolute phase of a wave in any experiment. If a lagrangian is invariant under gauge transformation in which the phase is dependent on space-time then such theories are known as local gauge theories. If the Lagrangian is locally gauge invariant under the particular symmetry transformation, it automatically gives the interaction of the lagrangian with the external field. This is the crux and most important aspect of the gauge theories. The biggest boost to the gauge theories came from the work of Gerardus 't Hooft and Martinus J.G. Veltman (Nobel prize 1999) who showed that all gauge theories are renormalisable. The term renormalization needs some explanation.

From the basic interaction of the theory for a particular process, one can write down the Feynman diagrams (FD) which gives the scattering amplitude (M_{fi}) for a given process. The FD are purely symbolic; they do not correspond to particle trajectories (as you might see them in, say, bubble chamber photograph). In FD the vertical dimension is time, and the horizontal spacings do not correspond to physical dimensions (see figure below). In the figure below, photon is the Feynman propagator internal line. It represents creation of the particle (virtual) at one vertex, its propagation to other vertex and its annihilation. For instance, in the diagram below, all that the FD says is once there was an electron and a positron; they exchanged a photon; then there was an electron and an electron again. Each FD actually stands for a number, which can be calculated using the so-called Feynman rules. First analyse a given process say, the electron-electron scattering (figure below).

Here, one writes down all the diagrams that have the appropriate external lines (the one with two vertices, all the ones with four vertices, and so on), then evaluate the contribution of each diagram, using Feynman rules, and add it all up. The sum total of all the FD for any particular process with the external lines represents the physical process. The Feynman rules enforce conservation of energy and momentum at each vertex (the point of interaction). But, some of the diagrams become infinite and hence needs to be renormalized (made finite). Once the Mfi is written down, one can compute cross section or the lifetime for a given process. QED is a U(1) abelian gauge theory. Here, we demand QED lagrangian to be invariant under local U(1) gauge transformation. The QCD is an SU(3) non-abelian gauge theory (non-abelian since the generators of the group do not commute). Here, the QCD Lagrangian is to be invariant under local SU(3) gauge transformation. Each flavour quark comes in three colors, red, blue and green. Although the various flavours carry different masses, the three colors of a given flavour weigh the same. Invariance of the Lagrangian under local $SU(3)_{color}$ transformation leads to Yang-Mills equation which gives interaction between the quarks and gluons and the self interaction of the gluons.

Figure 1: Electron-Electron Scattering



4.2 Quark Gluon Plasma (QGP)

The concept of asymptotic freedom suggests a phase transition of hadronic, the QCD matter at low temperature (T) and low baryon density (n_B) in which quarks and gluons are confined, into a new deconfined phase of matter called quark gluon plasma, at high temperature and high density. Plasma by definition, are quasi neutral gas of charged and neutral particles that exhibits collective behaviour. Quarks are the constituents of nucleons. Usually they are confined in groups of three to form a nucleon. Under certain conditions there should exist a new phase where the nucleons get close to each other such that the quarks can fly around freely in a so called quark gluon plasma. This transition from hadrons to QGP leads to the change in degrees of freedom in a strongly interacting medium. Lattice QCD suggests the existence of such a phase transition at critical temperature T_c of about 150-200 MeV, which corresponds to a critical density ϵ_c= 1GeV/fm^3 (depends on the quark flavour N_f). Lattice gauge theory was developed by K. G. Wilson in 1974.

Lattice gauge theory is a tool to study non-perturbative QCD from the first principle by numerical computation. Lattice theory treats the four dimensional space-time as a lattice like in crystals, in which quarks occupy lattice points or lattice sites while gluon field occupies lattice links. The lattice approximation approaches continuum QCD as the spacing between lattice sites is reduced to zero. Using lattice technique, QCD may be solved using Monte-Carlo method.

4.3 Big-Bang Theory

The big bang model says that the universe began about 13.7 billion years ago as a tiny point of infinite density and zero size. This spot and after the explosion, all the particles of matter and anti-matter rushed outward, away from each other. According to the Big-Bang theory evolution of the Universe took place in the following manner. At the time of big bang matter and anti matter were supposed to be in equal quantities. 1) QGP was supposed to have been formed 10^{-9} seconds after the Big-bang 2) After 0.01 sec protons and neutrons were formed 3) After 100 sec. formation of the Helium Nuclei 4) After 105 years first atom was formed. Big-bang predicts 1) 75% of the visible matter is hydrogen and 25% of the matter is Helium 2) Presence of background microwave radiation.

4.4 Neutrinos

The neutrinos were postulated by Fermi in 1930 to explain β spectra on purely theoretical grounds. Believed to have zero mass, no charge and undergo only weak interaction. Important property is all neutrino's are left handed (direction of the momentum is opposite to the direction of the spin) and anti-neutrino's are right handed (direction of the momentum is opposite to the direction of the spin) (see figure below) and it comes in three flavors ν_e, ν_μ and

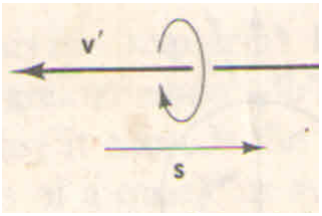
ν_τ. The electrons on the other hand are both left and right handed. The neutrinos are massless and travel with the speed of light.

In fact, electron, proton and neutrons are rarities for each of them in the universe, there is 1 billion neutrinos. Neutrinos are the most abundant matter-particles in the universe. Neutrinos are found everywhere in the outer space, on earth and in our bodies. The number of neutrinos from the Sun that are passing through the fingernail in one second is about 40 billion.

The most intriguing aspect of weak interactions is, it violates parity (Parity is a valid symmetry of strong and electromagnetic interaction). This was theoretically predicted by Yang and Lee in 1956 (Chen Ning Yang and Tsung Dao Lee, Noble prize 1957). It was experimentally verified by C.S. Wu (C.S. Wu et al., Phys. Rev. 104, 254, (1956)). The parity is the space inversion operator (reflection in X-Z plane + rotation by π degrees about Y-axis, in Cartesian coordinate system). Parity is a Hermitian and unitary operator. Parity of a particle is the product of intrinsic parity and the parity of the orbital angular momentum. Fermion and anti-fermions have opposite parity where as bosons have same parity. For mesons parity is $(-1)^{L+1}$ (L is the orbital angular momentum) and for photons parity is $(-1)^N$, where N is the number of photons. Physicists thought that the mirror image of an object or a process was indistinguishable from the object or process itself. Let us take a simple example which violates parity. Suppose you were holding a ball in your right hand and allowed it to fall. Obviously the ball would fall on the floor. In the mirror it would be a left hand which drops the ball. The image ball would also drop on the floor. Here the mirror image corresponds to reality. However, if you had a special ball discovered by someone, which falls down whenever it is dropped from right hand, but goes up when dropped from the left hand then the mirror symmetry would be broken. This is because the mirror image of this special ball falling down from the right

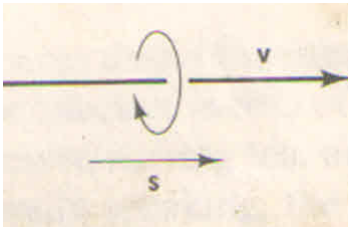
hand would be a ball falling down from the left hand, a situation contradicting reality. Further, weak interactions are not invariant under Charge conjugation(C) and also under the combined operation of both C and Parity (CP). Also it was observed that the neutrinos which are present in all weak interactions (in fact it is the signature of the weak interactions) are left handed (the direction of the spin is opposite to the direction of momentum) and all antineutrinos are right handed (the direction of the spin is along the direction of momentum),

Figure 2: Neutrinos (Left-handed)



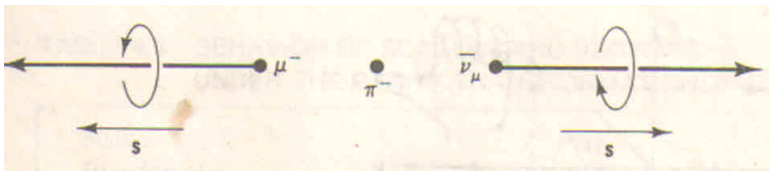
In the decay of $\pi^- \longrightarrow \mu^- + \bar{\nu}_\mu$, if pions were to be at rest, the muon and the anti neutrino should come out back to back and also since the pion has spin zero, the muon and antineutrino spin must be oppositely aligned (see figure below). Hence, the anti neutrino must be right handed in the rest frame of the pion and this was observed experimentally. Hence, measurement of the muon helicity enables to determine the helicity of the antineutrino. Hence the

Figure 3: Anti-neutrinos (Right-handed)



mirror image of the neutrino does exist. The following figure shows the decay of π^- at rest.

Figure 4: The decay of π^- at rest



4.5 Experimental Evidence of Parity Violation

In 1956, Lee and Yang discovered that parity is not conserved in weak interaction. They proposed a test, which was carried out by C.S Wu. In the experiment, radioactive Cobalt 60 nuclei were

aligned such that their spins were along the direction of the magnetic field (see figure below). Cobalt undergoes beta decay

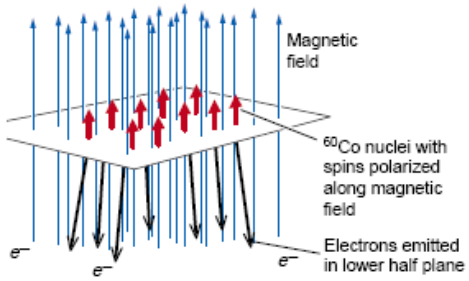
$$^{60}_{26}Co \longrightarrow ^{60}_{27} Ni + \ e^- + \bar{\nu}_e$$

and Wu recorded the direction of the emitted electron and found that there were along the direction of the nuclear spin. If one examines the mirror image of the same process, the image nucleus rotates in the opposite direction and its spin is downwards. But, the electrons in the mirror still came in the upward direction. This implies that, in the mirror, electrons are emitted preferentially in the direction opposite to the nuclear spin. Hence, the mirror image of the process does not occur in nature. Hence, parity is not an invariance of the weak interaction. If it were, the electrons should have come out in equal distribution. For example, in the decay of neutral pion $\pi^0 \longrightarrow \gamma + \gamma$, which is an electromagnetic process and hence respects parity. The number of emitted right handed pairs is equal to the number of left handed photon pairs.

4.6 Double Beta Decay

Double beta decay is a radioactive decay process where a nucleus releases two beta rays as a single process. Here two neutrons in the nucleus are converted to two protons and two electrons and two antineutrinos. In order to the beta decay to be possible the final nucleus must have larger binding energy than the original nucleus. Double beta decay is difficult to study since both beta decay and double beta decay are possible and the probability favouring beta decay. Hence, the double beta decay is studied only for beta stable nuclei. Like single beta decay, double beta decay does not change the mass number. In fact, it is a second order weak process in

Figure 5: Radioactive Cobalt 60 nuclei were aligned such that their spins were along the direction of the magnetic field



which two neutrons inside a nucleus spontaneously transform into two protons. The double beta decay can be broadly classified into four categories. They are 1) Two neutrino double beta decay 2) Neutrinoless double beta decay 3) Single Majorana accompanied neutrinoless double beta decay and 4) Double Majorana accompanied neutrinoless double beta decay. The decay modes can occur via 1) Emission of two electrons 2) Emission of two positrons, 3) Electron-positron conversion and 4) Double electron capture. Majorana particles are identical with their own anti particles unlike the Dirac particles which can be distinguished from their anti particles.

5 Weak Interactions

5.1 Weak Interaction and Unification with the Electromagnetic Interaction (Electroweak Unification:$SU(2)_L$ x $U(1)_Y$ Theory)

To explain beta decay, Fermi treated the weak interaction process as a contact interaction, occurring at a single point, and therefore requiring no mediating particle. It works well at low energies but fails completely at high energies. Also, it is not a renormalisable theory. The weak interactions have a very short range of the order of 10-16cms and hence according to the QFT should be mediated by very massive particles. Weak interactions take place between all quark and leptons constituents: each of them has to be assigned a weak charge g which is related to the electric charge. But, with the emergence of the electroweak theory of Glasow, Weinberg and Salam (GWS) (Nobel Prize 1979) predicted that weak interactions are mediated by three spin 1 bosons two of them charged (known as $W^{\pm}$ with a mass of 82 GeV) and Z boson (with a charge = 0 and mass 92 GeV). In the late seventies, CERN began construction of a proton-antiproton collider designed specifically to produce these extremely heavy particles. In January 1983 $W^{\pm}$ and Z bosons were experimentally detected by Carlo Rubbia's group (Carlo Rubbia and Simon Van Der Meer, Nobel Prize 1984), and George Charpak (Nobel Prize 1992 for his invention and development of particle detectors). So, weak interaction was placed on a firm footing. It is important to know the following aspects of the weak interactions.

5.1.1) The weak coupling constant $\alpha_w = 1/29$ and hence is much larger than the electromagnetic coupling constant $\alpha = 1/137$, by a factor of nearly 5. It should be noted that weak interactions are not

weak because the intrinsic coupling is small, but because the mediating particles are very massive. Since we work typically at energies so far below the W mass that the denominator in the propagator is extremely large. But in e^-e^+ collider at Z^0 resonance weak interactions simply dominate over the electromagnetic interaction.

5.1.2) There are two types of weak interactions. The neutral current interaction (mediated by Z^0 particle) and charged current interaction (mediated by $W^{\pm}$, typical example is the beta decay). In the neutral current interaction, for example,

$$e^- + e^+ \longrightarrow \mu^+ + \mu^-$$

can occur either by a virtual Z^0 or by a virtual photon. At low energies the photon mechanism overwhelmingly dominates. But, in the neighbourhood of the Z^0 mass, where the denominator of the Z^0 propagator is small the weak interaction cross sections are very large compared to the electromagnetic cross sections. One of the biggest successes of the GWS theory was the prediction of the weak neutral current interaction. It is important to note that every electromagnetic process is contaminated by weak neutral process leaving a foot print of parity violation.

5.1.3) The leptons carry no colour, and they do not undergo strong interactions. Neutrinos have no charge and do not participate in electromagnetic interaction. But all of them undergo weak interactions.

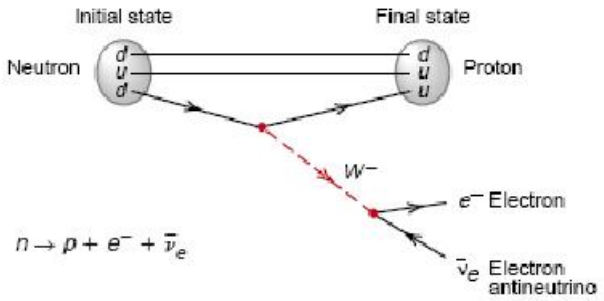
The basic problem with the Fermi theory is that, it is a Vector-Vector (V-V) theory (for example **P** the momentum is a vector and changes sign under parity whereas, **L** the angular momentum is an axial vector and does not change sign under parity) and hence is invariant under parity. Further, it was based on contact interaction. Based on experimental observations (violation of parity) and

in consistency with the QFT, it was boldly proposed by Sudharshan and Marshak and independently by Feynman and Gillmann, that the weak interactions are Vector-Axial vector type (V-A). The input came from the experiments. To incorporate weak neutral current (J^{NC}) and weak charged current J±, the group was chosen as SU $(2)_L$ x U $(1)_Y$. Here, L stands for left-handed and Y stands for hypercharge. SU(2) has 3 generators. Out of the 3 generators two $T^+$and T^- corresponds to charged currents. But, J^{NC} is not purely left handed. Therefore there was need to enlarge the group. Y, the hypercharge is the generator of U(1)Y group. Since the electromagnetic current J^{EM} is both left handed as well as right handed, J^{EM} was included in the theory so as to save the $SU(2)_L$ symmetry (J^{EM} = J_3 + Y/2). Thus, the electromagnetic interaction was incorporated into the theory. That is, we have two groups each with an independent coupling strength. So, in addition to e, we need another coupling to fully specify electroweak interaction. In the standard mode, the three weak currents couple, with strength gw, to a weak isotriplet of intermediate vector bosons W, and the weak hypercharge current

$$Q = I_3 + \frac{Y}{2}; j_\mu^Y = 2\ j_Y^{EM} - 2\ j_\mu^3$$

couples with strength g'/2 to an isosinglet intermediate vector boson B. The standard model for the weak and electromagnetic interaction is constructed from a gauge theory mediated by four gauge bosons, (the photon, $W^\pm$ and Z^0). The masses for $W^\pm$ and Z^0 are generated by spontaneous symmetry breaking (SSB). Our present understanding of the neutron decay is illustrated in the figure below.

Figure 6: Neutron decay



5.2 Basic Idea of SSB and Higgs Mechanism

For the gauge invariance, the gauge boson has to be massless. It is not a problem in QED and QCD since both photons and gluons are massless. But, weak interactions are mediated by $W^{\pm}$ and Z^0 which are massive particles. To generate the masses from a massless theory is achieved through SSB. To start write down the Lagrangian which is invariant under the gauge group (here $SU(2)_L$x $U(1)_Y$). The Lagrangian is invariant, but the ground state (vacuum) is not. If one of the ground state is singled out as the physical state of the system (the others being unphysical), the symmetry is lost and the theory is said to be spontaneously broken i.e. the ground state is no more invariant under the symmetry transformation but the Lagrangian is still invariant. If symmetry is broken spontaneously globally, then there will be one or more massless (spin 0) particles called Goldstone bosons. This in literature is termed as Goldstone theorem. But, if the symmetry is broken locally then these massless bosons acquire mass and this mechanism is known as Higgs mech-

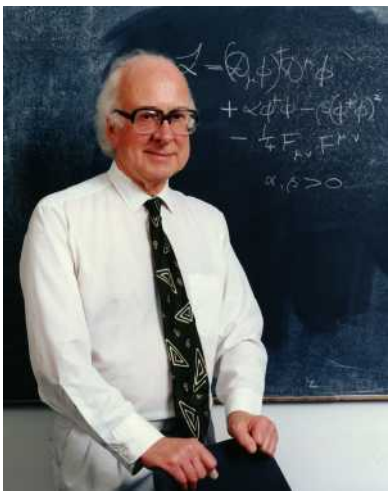
anism. In standard model, the Higgs mechanism is responsible for the masses of all the particles. The gauge principle is responsible for the masses of all the particle interaction in electroweak theory. The Higgs particle couples to leptons, quarks and to the gauge bosons. Higgs boson was first proposed by a group of six theoretical physicists, who worked independently, most notably by Peter Higgs. Higgs boson and its corresponding field is responsible for the spontaneous symmetry breaking mechanism through which the fermions and the W^+, W^- and Z bosons acquire mass. The more a particle interacts with this field, the heavier it is. Particles like photons and gluons do not interact with the Higgs field and hence do not acquire mass. The Higgs boson are the only scalar particles (spin zero). In the 'Standard Model' the origin of mass is addressed using a mechanism named after the British physicist Peter Higgs. This predicts a new particle: The Higgs boson.

The Nobel Prize for Physics in 2013 has been awarded to Peter Higgs and Francois Englert, a Briton and a Belgian, 'for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider'.

Almost 50 years ago in 1964, Englert and Robert Brout, who died in 2011, and Peter Higgs independently published their work in the span of a few days. They had described a mechanism making use of what was known about particle physics at that time to try to answer a perplexing problem: How do particles acquire mass?

Higgs and Englert hypothesized a quantum field, which is a distribution of some energy, throughout the universe. When the field is disturbed, waves travel through it. The dimmest possible wave is

Figure 7: Peter Higgs



called a particle. In this field, since called a Higgs field, the associated particle is called the Higgs boson.
For physicists, finding the Higgs boson meant that the Higgs field exists. And because of the Higgs field and its properties, any fundamental particles that made through it cause Higgs bosons to clump around the particles. This clumping causes the particle to acquire energy and, therefore, mass.
The existence of the Higgs boson was confirmed at the Large Hadron Collider, near Geneva, Switzerland, over the last year. On July 4, 2012, first hints of the boson's existence were spotted at the collider. Ever since, a series of tests on the particle have yielded confirmation, establishing Higgs's and Englert's work as a cornerstone of modern particle physics.
Through an Edinburgh University statement, where Higgs is an

emeritus professor, he said he was overwhelmed to receive the award and congratulated 'all those who have contributed to the discovery of this new particle and to thank my family, friends and colleagues for their support. I hope this recognition of fundamental science will help raise awareness of the value of blue-sky research'.

6 Solar Neutrinos

6.1 Solar Neutrinos Problem

The observed ν_e on the earth is about $1/3^{rd}$ of the theoretically predicted ν_e's produced by the sun.

6.1.1 There is a major discrepancy between measurements of the numbers of neutriono's and observed number of neutrinos predicted by Standard Model (SM).

6.1.2 In SM neutrino's are massless

The solar neutrino problem was a major discrepancy between measurements of the numbers of neutrinos flowing through the earth and theoretical models of the solar interior, lasting from the mid-1960s to about 2002. The discrepancy has since been resolved by new understanding of neutrino physics, requiring a modification of the Standard Model of particle physics specifically, neutrino oscillation. Essentially, as neutrinos have mass, they can change from the type that had been expected to be produced in the Sun's interior into two types that would not be caught by the detectors in use at the time late 1960s.

Measurements: In the late 1960s, Ray Davis's and John N. Bahcall's Homestake Experiment was the first to measure the flux of neutrinos from the Sun and detect a deficit. The experiment used a chlorine-based detector. Many subsequent radiochemical and water Cherenkov detectors confirmed the deficit, including the Sudbury Neutrino Observatory.

The expected number of solar neutrinos had been computed based on the standard solar model which Bahcall had helped to establish and which gives a detailed account of the Sun's internal operation. In 2002 Ray Davis and Masatoshi Koshiba won part of the Nobel Prize in Physics for experimental work that found the number of solar neutrinos was around a third of the number predicted by the standard solar model.

6.2 Resolution of the Solar-neutrino Problem

The solar neutrino problem was resolved with an improved understanding of the properties of neutrinos. As discussed already, according to the Standard Model of particle physics, there are three different kinds of neutrinos 1) electron neutrinos ((ν_e) (which are the ones produced in the Sun and the ones detected by the above-mentioned experiments, in particular the chlorine-detector Homestake Mine experiment), 2) muon neutrinos (ν_μ) and 3) tau neutrinos (ν_τ) . Through the 1970s, it was widely believed that neutrinos were massless and their types were invariant. However, in 1968 Pontecorvo proposed that if neutrinos had mass, then they could change from one type to another. Thus, the 'missing' solar neutrinos could be electron neutrinos which changed into other types along the way to Earth and therefore were not seen by the detectors in the Homestake Mine and contemporary neutrino observatories. The supernova 1987A produced an indication that neutrinos might have mass, because of the difference in time of arrival of the neutrinos detected at Kamiokande and IMB. However, because very few neutrino events were detected it was difficult to draw any conclusions with certainty. The first strong evidence for neutrino oscillation came in 1998 from the Super-Kamiokande collaboration in Japan. It produced observations consistent with muon-neutrinos (produced in the upper atmosphere by cosmic rays) changing into tau-neutrinos. What was proved was that fewer neutrinos were de-

tected coming through the Earth than could be detected coming directly above the detector. Not only that, their observations only concerned muon neutrinos coming from the interaction of cosmic rays with the Earth's atmosphere. No tau neutrinos were observed at Super-Kamiokande. The convincing evidence for solar neutrino oscillation came in 2001 from the Sudbury Neutrino Observatory (SNO) in Canada. It detected all types of neutrinos coming from the Sun and was able to distinguish between electron-neutrinos and the other two flavors (but could not distinguish the muon and tau flavours), by uniquely using heavy water as the detection medium. After extensive statistical analysis, it was found that about 35% of the arriving solar neutrinos are electron-neutrinos, with the others being muon- or tau-neutrinos. The total number of detected neutrinos agrees quite well with the earlier predictions from nuclear physics, based on the fusion reactions inside the Sun. In particle physics, neutral particle oscillation is the transmutation of a particle with zero electric charge into another neutral particle due to a change of a non-zero internal quantum number via an interaction that does not conserve that quantum number. For example, a neutron cannot transmute into an antineutron as that would violate the conservation of baryon number.

6.3 India-based Neutrino Observatory

India-based Neutrino Observatory (INO) is a Particle Physics Research Project under construction to study primarily, the atmospheric neutrinos in a 1,300 meters (4,300 ft) deep cave under Ino Peak near Theni, Tamil Nadu, India. This project is notable in that, it is anticipated to provide a precise measurement of neutrino mixing parameters. The project is a multi-institute collaboration and one of the biggest experimental Particle Physics projects undertaken in India. The project was originally to be completed in 2015 at an estimated cost of 1,500 crores, has been cleared by the

Ministry of Environment (India) for construction in the Bodi West Hills Reserved Forest in the Theni district of Tamil Nadu. Although delayed, the project is underway. When completed, the main magnetized iron calorimeter (ICAL) experiment include the world's most massive magnet, four times larger than the 12,500-tonne magnet in the Compact Muon Solenoid detector at CERN in Geneva, Switzerland.
The Primary goals of the INO are the following.
6.3.1 Unambiguous and more precise determination of Neutrino oscillation parameters using atmospheric neutrinos.
6.3.2 Study of matter effects through electric charge identification, that may lead to the determination of the unknown sign of one of the mass differences.
6.3.3 Study of charge-conjugation and charge parity (CP) violation in the leptonic sector as well as possible charge-conjugation, parity, time-reversal (CPT) violation studies.
6.3.4 Study of Kolar events, possible identification of very-high energy neutrinos and multi-muon events.

The Nobel Prize in physics has been awarded to Takaaki Kajita and Arthur McDonald for discovering that elusive subatomic particles called neutrinos weigh something more than nothing. Named after the Italian for 'little neutral one', neutrinos have no electric charge and were long thought to have zero mass, but Kajita at the University of Tokyo and McDonald at Queen's University in Kingston, Canada, showed otherwise. With two separate detectors built deep underground, one a kilometer beneath a mountain in Gifu prefecture, and the other 2 km down an old nickel mine in Ontario, the scientists discovered that neutrinos can flip from one form to another as they hurtle through space a chameleon-like behavior that proves they have mass. The Nobel committee said, the discovery had 'changed our understanding of the innermost work-

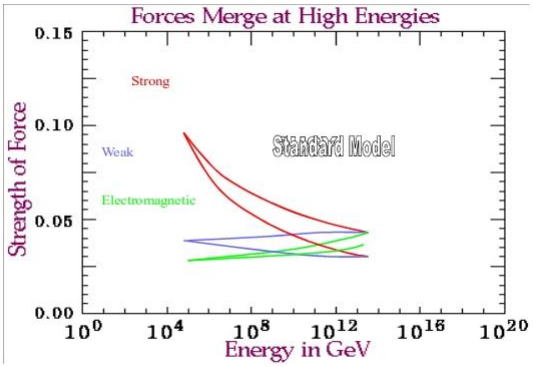
ings of matter and can prove crucial to our view of the universe'. Asked by reporters in a call following the Nobel announcement how it felt to have won the prize, McDonald described the discovery as a 'eureka moment' and said, 'It's a very daunting experience needless to say. Fortunately, I have many colleagues as well who share this prize with me'.

7 Grand Unification Theory (GUT)

GUT is the basic theory developed to unify the strong with the electroweak theory. Beginning in the early seventies, many people have been working on the obvious next step, combining the strong force with the electroweak force. Several different schemes for implementing this grand unification are now on the table, and although it is too soon to draw any definitive conclusions, some of the early results are promising. In QCD strong coupling decreases at short distances so do the weak coupling (α_w). Also, the electromagnetic coupling (α) which is smallest of the three, increases. The question addressed is: Will all these couplings converge to a common limiting value at extremely high energies. From the functional form of the coupling constants it is estimated that at 10^{15} GeV the three forces coupling constant should be the same (see figure below). In the simplest version of the GUT the gauge group describing all interactions is SU(5) which contains as its subgroup the gauge group SU(3) x SU(2) x U(1). The quarks and leptons are put in the same representations of the group. There are 24 gauge bosons. One of the important predictions of the GUT is that proton is not a stable particle, although its half-life is 10^{31} years (at least 10^{20} times the age of the universe). The hectic search for the decay of proton has met with negative result. If grand unification works, all the elementary particle physics will be reduced to the action of a single force. The final step then will be to bring in gravity, the dream of

Einstein. Many theorists are already working in this direction.

Figure 8: Forces Merge at High Energies



8 Beyond the Standard Model

8.1 Short Comings in Standard Model

There are many short comings in the standard model such as the strong CP problem, neutrino oscillations, matter-anti matter symmetry, and the dark matter and dark energy etc. Another problem with the standard model is that it incorporates only three of the four fundamental forces, omitting gravity. The model is also unsuccessful in explaining why gravity is so much weaker than the electromagnetic force or strong forces. Also, SM cannot provide

justification for the three generations of quarks and leptons with such a diverse mass scale. The hierarchy problem is also associated with the Higgs boson mass. Another problem with the SM is it describes only visible matter, and cannot explain the nature of the dark matter and dark energy. Many attempts in the theoretical and experimental physics are going on to extend the SM through super symmetry or new theories like Minimal Supersymetric Standard Model (MSSM), string theory and extra dimensions. In spite of these deficiencies, the SM is the most successful theory of particle physics to date.

8.2 Dark Matter and Dark Energy

Dark matter is a hypothetical kind of matter that cannot be seen with telescopes but would account for most of the matter in the universe. The existence and properties of dark matter are inferred from its gravitational effects on visible matter, on radiation, and on the large-scale structure of the universe. Dark matter has not been detected directly, making it one of the greatest mysteries in modern astrophysics. Hence, dark matter refers to the invisible non luminous matter in the universe which does not interact with the electromagnetic radiation. This is held as a direct evidence of the existence of the dark matter. According to the Virial Theorem, the total energy should be half of the potential energy. But, experimentally the total kinetic energy is found to be much greater than the total gravitational binding energy of the galaxies. It is said that dark matter is able to bend the light. The Swiss astrophysicist Fritz Zwicky, of the CIT in 1933 applied the virial theorem to the Coma cluster of galaxies and obtained evidence for unseen mass. The 4.9% of the matter of the universe is ordinary matter and 26.8 % is composed of dark matter and 68.3 % is thought to consist of Dark energy. Many Particle Physics candidates for Dark Matter have been proposed and several projects to detect them directly or

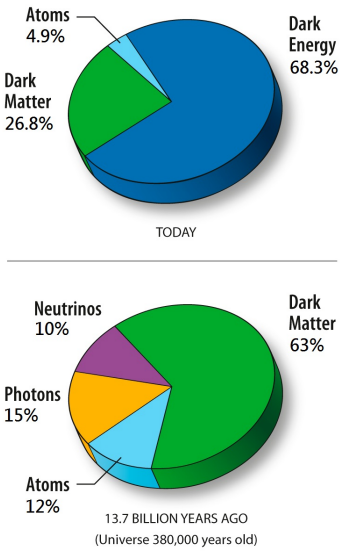
under way. The probable candidates for the dark Matter are 1) exotic new particles 2) black holes and 3) neutrinos (likely to be verified at LHC).

The 2011 Nobel prize in Physics was awarded for the accelerating expansion of the Universe to Saul Perlmutter of Lawrence Berkeley National Laboratory and the university of California, Berkeley, Brian Schmidt of the Australian National University and Adam Riess of Johns Hopkins University and the Space Telescope Science Institute, Baltimore 'for the discovery of the accelerating expansion of the Universe through observations of distant supernovae', a discovery has reshaped our understanding of the cosmos and the ultimate fate of the universe. The work constrains the ultimate fate of the universe, addresses Einstein's cosmological constant, an element of the theory of relativity. It provides the frame work for the concept of dark energy which makes up approximately 75% of the matter and energy in the universe

8.3 Super Symmetry

The Electroweak Theory and the GUT are incomplete. Super symmetry relates fermions to bosons. This is a symmetry which tells us that if we have a boson we must have a fermion partner and vice versa. Thus, every fermion (quark or lepton) will have a super symmetric (SUSY) spin zero partner (squark, slepton) while every boson (photon, gluon, W, Z and Higgs) has a spin 1/2 partner. The quantum of gravitational force, the gravitation, which has spin 2, will have super symmetric partner graviton with spin 3/2. In the super symmetric limit, the particles and their super symmetric partners should have equal masses. The discovery of super particles would certainly be a triumph of symmetry ideas. At present, super symmetry is only an attractive idea.

Figure 9: Dark Matter and Dark Energy



8.4 Superstring Theories

Superstring theories combine the interaction of particle physics with gravity and are essentially a geometric theory. In string theories the elementary constituents are not points in space but curves (or strings) in a D-dimensional space, where D is considerably greater than 4, with D =10 being the value the current theory requires. The elementary particles are different vibrational modes of the string. Since the gravity becomes important at the Planck's scale (10^{19}GeV or 10^{-33} cm). The superstring theories can be tested only at this energy, and hence are still far from verification.

Summary of the Elementary Particles and Their Interaction

Table 3: Fundamental Interactions (Mc^2 = 1 GeV)

	Gravitational	**Electromagnetic**	**Weak**	**Strong**
Field Bosons	Graviton (?)	Photon	W+, W- , Z	Gluons
Spin-parity	2+	1-	1-,1+	1-
Mass(GeV)	0(?)	0	M_W= 80.2 GeV M_Z = 91.2 GeV	0
Range	∞	∞	10^{-16} cm	10^{-13} cm
Source	Mass	Electric Charge	Weak Charge	Colour Charge
Coupling Constant	5×10^{-40}	1/137	1.17×10^{-5}	$\alpha_s \leq 1$
Typical cross section, m^2	-	10^{-33}	10^{-39}	10^{-30}
Typical Life Time , sec.	-	10^{-20}	10^{-10}	10^{-23}

Table 4: Quantum Numbers of the Quarks, $Q = I_3 + \frac{1}{2}(B+ S+C+ B^*+T)$ (Here B denotes the Baryon Number and B^* denotes the Bottom Quantum Number)

Flavour	I	I_3	B	S	C	B^*	T	Q	Effective Mass in Baryons MeV/C^2	Bare Mass MeV/C^2
u	1/2	1/2	1/3	0	0	0	0	2/3	363	4.2
d	1/2	-1/2	1/3	0	0	0	0	-1/3	363	7.5
s	0	0	1/3	-1	0	0	0	-1/3	538	150
c	0	0	1/3	0	1	0	0	2/3	1500	1100
b	0	0	1/3	0	0	-1	0	-1/3	4700	4200
t	0	0	1/3	0	0	0	1	2/3	1,74,000	1,74,000

Table 5: Fundamental Leptons

Leptons	J	Mass MeV/c^2	Lifetime
e^-	1/2	0.511099907	Stable
μ^-	1/2	105.658389	2.197×10^{-6} s
τ^-	1/2	1777.0 0.3	(291 + 1.5) x 10^{-15} s
ν_e	1/2	$<$ 10 eV	Stable
ν_μ	1/2	$<$ 0.16 MeV	Stable
ν_τ	1/2	$<$ 18 MeV	Stable

9 Conclusion

The field of elementary-particle physics has made dramatic progress over the past 25 years in understanding the fundamental structure

Table 6: Fundamental Bosons

Gauge bosons	J^{PC}	**Mass (GeV/c^2)**	**Width** GeV
Photon	1^{--}	$< 10^{-26}$	Stable
Gluon	1^{-}	0	Stable
Weak bosons			
$W^{\pm}$	$1^{\pm}$	80.33±0.15	Ґ=2.07±0.06
Z	$1^{\pm}$	91.187±0.007	Ґ=2.49±0.01

Table 7: Conservation Laws

Sl.No	**Conservation Law**	**Strong**	**Electromagnetic**	**Weak**
1	Baryon Number (B)	Yes	Yes	Yes
2	Lepton Number (L_e,L_μ, and L_τ) are Separately conserved	Yes	Yes	Yes
3	Iso-spin (I)	Yes	No	No
4	Third Component of Iso-spin (I_3)	Yes	Yes	No
5	Strangness (S)	Yes	Yes	No
6	Electric Charge (Q)	Yes	Yes	Yes
7	Parity (P)	Yes	Yes	No
8	Charge Conjugation (C)	Yes	Yes	No
9	CP	Yes	Yes	No
10	CPT	Yes	Yes	Yes
11	Energy, Momentum and Angular Momentum	Yes	Yes	Yes

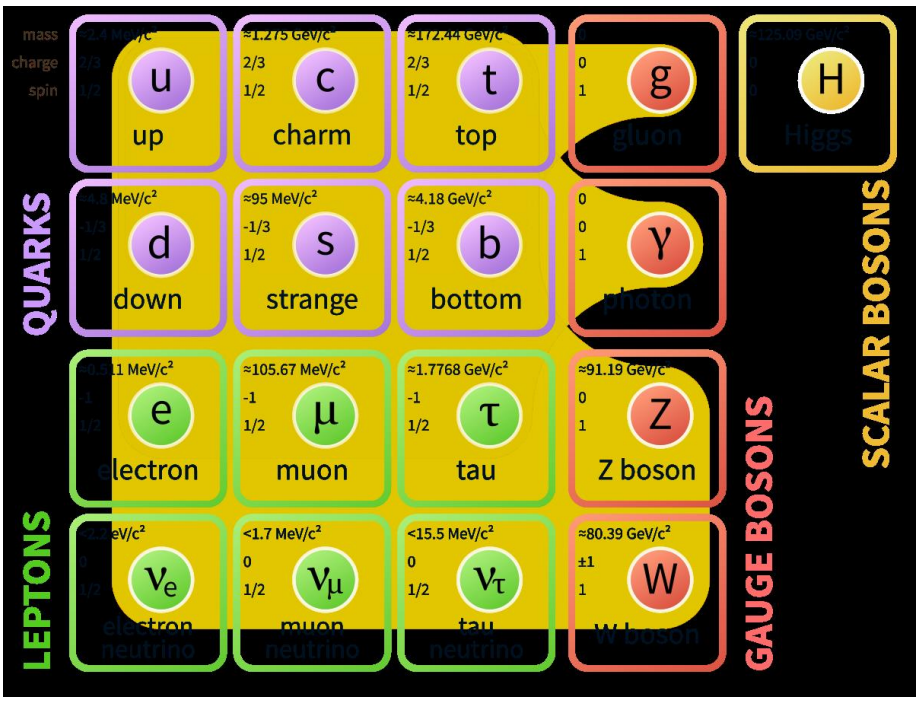
of matter. Recent discoveries and technological advances are en-

Figure 10: Leptons:List of the Fundamental Particles Leptons and corresponding anti particles; Total (6 x 2=12),Qurks: Quarks and corresponding anti-particles; Total (6x3x2=36);(Each quark comes in three colors)

Leptons/Anti-leptons				Quarks/Anti-quarks			
e^- Electron	e^+ positron	ν_e electron neutrino	$\overline{\nu_e}$ electron anti-neutrino	u up	$\bar{u}$ anti-up	d down	$\bar{d}$ anti-down
μ^- Muon	μ^+ Anti-muon	ν_μ muon neutrino	$\overline{\nu_\mu}$ muon anti-neutrino	C charm	$\bar{C}$ anti-charm	S strange	$\bar{S}$ anti-strange
τ^- Tau	τ^+ anti-tau	ν_τ tau neutrino	$\overline{\nu_\tau}$ tau anti-neutrino	t top	$\bar{t}$ anti-top	b bottom	$\bar{b}$ anti-bottom

abling high-energy physicists to address such compelling scientific issues as why elementary particles have mass, the excess of matter over antimatter in our universe, and the fundamental nature of the breaking of electroweak symmetry. In this article an attempt has been made to explain the fundamental particles, fundamental forces and their interactions. The article also gives information about the current experimental facilities to detect elementary particles. The complete list of our understanding of the elementary particles, and their interactions and the conservation laws obeyed by them are listed in Tables 3-7, Figure 10 and Figure 11.

Figure 11: Leptons: Leptons and corresponding anti particles; Total (6 x 2=12),Qurks: Quarks and corresponding anti-particles; Total (6x3x2=36);(Each quark comes in three colors),Gauge bosons: Photons, Gluons (8), $W^{\pm}$, Z and the Higgs particle; Total 13,
Total number of fundamental particles 61



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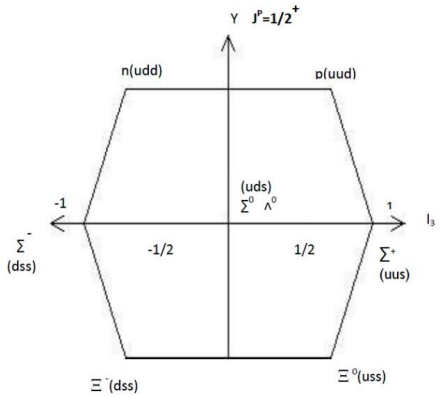
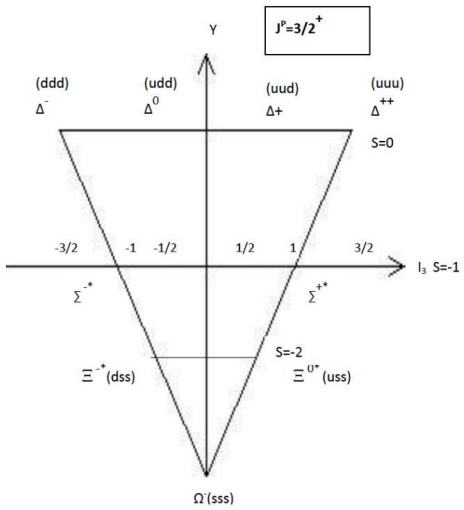
Appendix I

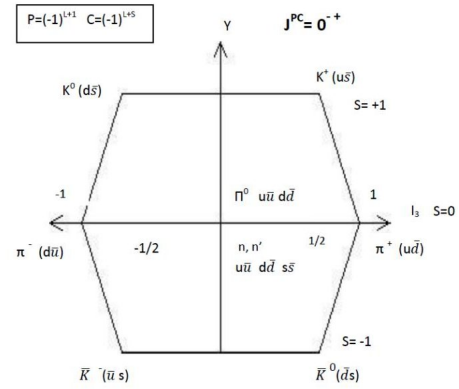
SU(3) Quark Model Baryons
Baryon Octets and Decouplets

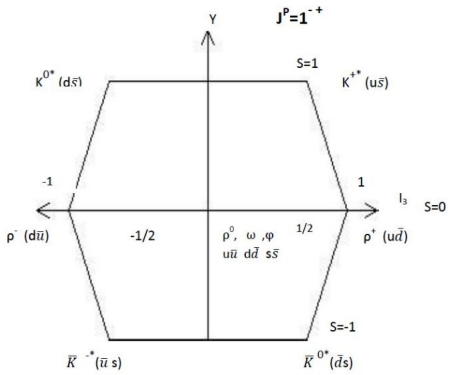




SU(3) Quark Model Mesons

Meson Nonets





Livestock-population for the Sustainable Development of Kerala

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Abstract: *Livestock have been an integral component of the agricultural and rural development of Kerala economy. They supply energy for crop production in terms of draught power and organic manure and in turn, derive their own energy requirements from crop by-products and residues. It is a source of food, raw material and by products in the form of hides and skins, blood, bone, fat, etc. The rate of increase in the demand for animal products is increasing globally. The livestock sector is also a major livelihood provider and an important secondary source of income and employment for rural families requires sustained growth. The supply demand gap and projected demand for livestock products necessitates the growth of this sector in a sustainable way in the state.*

Key Words: *Livestock-population; Egg;meat;milk; Sustainable Growth; Kerala.*

Introduction

Livestock is an important source of livelihood for the poor and is an integral part of the agricultural economy of the country. This sector is contributing to the national economy in general and to agricultural economy in particular and is the provider of employment opportunities, supplier of animal protein and creator of social and financial security. In Kerala, small and marginal farmers and landless labourers own majority of the livestock resources contributing 28 percent of the agriculture GDP of the state. Thus an investigation on the livestock sector would lead to more inclusive development and empowerment of women for the sustainable development of the state and is attempted in this paper.

1. Review of Literature

Livestock plays a vital role for the households and used as a source of income in the rural area. It is predicted that by 2020, this sector will produce more than half of the agricultural output (Ahuja and Redmond, 2004). The demand is predicted to arise in developing countries due to high population growth and increasing household income (Karunakaran, 2017). The options for sustainable livestock in developing countries will provide growth in rural income and accelerate the pace of production (Mahapatra, 2012). Under the increasing population growth, shortage of agricultural land and increasing demand for livestock has created a pressure for formulating better agricultural resource management policies (Sasikumar, 2009). Sustainable growth is hard to attain under current economic and environmental policies (Kumar, *et al*, 2008) and livestock policies are carried out for long term agricultural and livestock development (Bardhan, *et al*, 2010). Socio-environmental issues related to sustainable livestock production provide assistance in developing a system which includes socio-economic and cultural dimensions (Kitalyi, *et al*, 2005) and mixed crop-livestock system goes beyond direct food production function (Birthal, *et al*, 2006). Sustainable livestock production systems are needed to feed the larger, more urban, richer and older population (Govt. of India, 2012). Quantitative information about the sustainability performance of existing livestock production systems in Kerala can aid the debate of which actions could be developed and implemented.

2. Methodology and Materials

The study used secondary data obtained from various printed and electronic sourcesof the Department of Economics and statistics, Thiruvananthapuram, State Planning Board, Thiruvananthapuram, Directorate of Economics and statistics, NSSO reports, Government of India and other reports.

3. Analysis and Discussion

3.1. Major Livestock-products, its Production and Marketing in Kerala

3.1.1 Milk: India is the leading milk producing country in the world. Among the major milk producing states, Uttar Pradesh (252 lakh million tonne), followed by Rajasthan (169 lakh million tonne), Gujarat (117 lakh million tonne) and Madhya Pradesh (108 lakh million tonne) are at the top. Kerala

ranks 14th position in milk production with 27 lakh million tonne. Growth of milk production in the state is far below to the national average and the contribution of Kerala to the annual milk production of the country is only 1.9 percent. The production of major live-stock products, trend and ownership is shown in tables 1, 2 and 3.

Table 1: Production of Major Livestock-products in Kerala

Sl. No.	Year	Kerala			India		
		Milk (in lakh million tonne)	Egg (in crore)	Meat (in lakh million tonne)	Milk (in lakh million tonne)	Egg (in crore)	Meat (in lakh million tonne)
1	2006-07	21.19	119.39	1.98	1026	5066	23
2	2011-12	27.16	170.48	4.26	1279	6645	55
3	2014-15	27.11	250.36	4.46	1463.1	7848.4	67

Source: Govt. of Kerala (2015), *Economic Review,* State Planning Board, Thiruvananthapuram: 57.

3.1.2 Egg and Meat: Kerala ranks 9th with 251 crore in egg production. In meat production Kerala's position is 7th with 4.5 lakh million tonne. Egg production in the state increased from 119.39 crore in 2006-07 to 250.36 crore during 2014-15. Meat production also increased from 1.98 lakh million tonnes to 4.46 lakh million tonnes between the year 2006-07 and 2014-15 (Table 1). Growth of egg production is far below the national level and for meat, it is almost same.

Table 2: Trends in Live-stock Population in Kerala During the Last Decade

Sl. No.	Live-stock	Percentage Change
1	Cattle	“18
2	Buffalo	“10.7
3	Goats	42.5
4	Pigs	“22.3
5	Fowls and Ducks	30.6

Source: Govt of Kerala (2015), *Economic Review*, State Planning Board, Thiruvananthapuram: 58.

3.1.3 Milk Marketing: In Kerala around 5569 lakh litres of milk is procured,of which 3535 lakh litres are sent to the dairies and 2034 lakh litreswere marketed locally. The procurement of milk by Kerala Co-operative Milk Marketing Federation (KCMMF) increased to 3637 lakh litres against the sale of 4487 lakh litres during 2014-15; showing wide gap between procurement and supply. In the state the milk price offered to farmers is highest compared to other states.

Table 3: Farm Size Category-wise Ownership of Live-stock in Kerala (in percentage)

Sl. No.	Farm Category (in hectare)	Cattle	Buffalo	Goats	Pigs	Poultry
1	Marginal (below 1.0)	87.70	86.57	92.62	57.48	93.54
2	Small (1.0-1.99)	8.41	8.35	4.99	17.63	4.55
3	Semi-medium (2.0-3.99)	3.09	3.95	1.85	10.28	1.54
4	Medium (4.0-9.99)	0.72	1.02	0.47	14.60	0.34
5	Large (10 and above)	0.08	0.11	0.07	0.00	0.03
6	All groups	100.00	100.00	100.00	100.00	100.00

Source: Govt of Kerala (2012), *Kerala Perspective Plan-2030*: 238.

3.1.4 Animal Health Care: Realising the importance of livestock in the state economy, various animal health care programmes were implemented through Animal Husbandry Department, 14 district veterinary centres, 50 veterinary polyclinics, 213 veterinary hospitals and 869 veterinary dispensaries.

3.1.5 Price of Inputs and Products: Average price of important inputs and products recorded increase during the period. In the last few years, except broiler chicken, there was an increase in the price of all categories of meat. The price of chicken increased by 17 percent, mutton by 9 percent, beef by 15 percent and pork by 9 percent; the price of fowl-white egg increased by 0.3 percent, brown egg by 5 percent and duck egg by 0.8 percent (Govt of Kerala, 2015). In the case of input, the price of straw and grass increased by 2 percent, groundnut cake increased by 9 percent, coconut cake by 26 percent and gingery oil cake by 7 percent.

As with the population, live-stock products also experienced a slump in its growth during the last decade demonstrated in table 4. Major livestock products, viz, milk and milk products and meat and meat products exhibited negative growth rates. Only minor products like wool, hair and other miscellaneous products showed positive growth.

Table 4: Trends in the Growth in Value of Output of Live-stock Population and Products in Kerala During the Last Decade

Sl. No.	Live-stock Products and Population	Percentage Change
1	Milk and Milk Products	1.56
2	Meat and Meat Products	“2.14
3	Egg	3.42
4	Wool and Hair	2.87
5	Others	“0.34
6	Total Livestock	1.64

Source: Govt of Kerala (2012), *Kerala Perspective Plan-2030*: 241.

3.2. Demand for Major Livestock-products in Kerala

The percapita consumption and demand for major livestock-products in Kerala is presented in table 5. The total demand consists of both household demand (direct demand) as well as indirect demand. Indirect demand arises mainly from consumption other than from the households; from industrial uses, use on account of seed, feed, wastage, etc. It is found that the demand for milk in Kerala was relatively high at the level of 2794.5 thousand tonnes and that for egg and meat were 2188 million numbers and 456.6 thousand tonnes respectively. It is found that production fell short of demand in all livestock-products in Kerala.

Table 5: Demand and Supply of Major Livestock-products in Kerala

Notes : *Percapita demand of egg expressed in numbers and total demand (household, indirect and total) in million numbers.

Source : Govt of Kerala (2012), *Kerala Perspective Plan-2030*: 243.

3.3. Projected Demand and Supply of Major Livestock-products in Kerala

The projected production and demand for livestock-products during 2020 and 2030 are provided in table 6. The projections suggest that if the current growth trend in the number of in-milk animals and milk yield continues to be the same in the future, total milk production would decline to 1913.7 thousand tonnes by the year 2030 from the present level of 2489 thousand tonnes. In the case of egg, projected supply also indicates an emerging situation of excess demand. The projections revealed a far

lower supply of 688.2 million eggs by the year 2030 (table 6). At present, Kerala meets 73 percent of its meat demand from its own production and the contribution is 333.2 thousand tonnes (table 5). Unlike with milk and eggs, the statistics on meat shows that its production has increased substantially during the last few years. However, projected demand shows gap in this sector also (table 6).

Table 6: Projected Demand and Supply of Major Livestock-products in Kerala.

Demand and Supply	Year	Livestock-products		
		Milk (in '000 tonnes)	Egg (in million numbers)	Meat (in '000 tonnes)
Projected Supply	2020	2159.1	1012.7	311.0
	2030	1913.7	688.2	302.0
Projected demand	2020	3293.0	3008.0	652.2
	2030	3519.5	3381.4	742.5
Projected Supply Demand Gap (in percent)	2020	-11.34	-19.95	-3.41
	2030	-16.06	-26.93	-4.41

Source: Computed from Govt. of Kerala (2012), *Kerala Perspective Plan-2030*: 243-248.

3.4. Sustainability of Livestock-population

The sustainable livestock strategy aims at reducing the environmental footprint of farms, improving milk production, farm profitability, and the well-being of people and animals involved (Govt of Kerala, 2015). The new strategy implemented by Government of Kerala for sustainable livestock-population has five pillars.

3.4.1 Enhance Competitiveness: The key constraints for improving productivity and profitability of milk production are (i) feed availability, (ii) shortage of improved stock, (iii) insufficient knowledge of raising management skills and (iv) access to affordable credit. To address these constraints and facilitate entrepreneurial initiatives, business linkages and know-how ensured competitiveness. For this the following action plans were

suggested: (1) adopt an enterprise-driven approach for the development of livestock sector, (2) paradigm shift in sourcing of animals: local is better, (3) increase fodder production, and (4) promote infrastructure, marketing and finance.

3.4.2 Attract the Best Talent: Dairy farming currently has a low social and economic status. As a result, this activity does not attract talent. So as to increase returns higher than the costs and attract people lot of steps were suggested to make the sector remunerative.

3.4.3 Social Welfare: Programmes suggested in this head includes (i) improvement and maintenances of safety and quality and minimisation of losses, (ii) implementation of livestock production identification programmes, and (iii) encouragement of accreditation and standards.

3.4.4 Animal Welfare: Action plan in this head includes: (i) strengthening of veterinary services and up-keeping of animals, (ii) legal framework, and (iii) mechanised sanitation of animals.

3.4.5 Environment: This pillar highlights the need to preserve the natural heritage of Kerala through proactive environmental stewardship and wise use of natural resources. The major environment related issues are nutrient contamination of soil, groundwater pollution, surface water eutrophication, ammonia emissions and loss of biodiversity. Better management of nutrients, waste, and water may be one of the practical policy options in this direction. This can be achieved through training, research and development, mechanisation and integrated farming systems.

Conclusion

Kerala is home to a range of livestock species. The livestock in the state are raised both in backyards and commercial farms. Cattle, buffaloes, goats, pigs, ducks and fowl, rabbits, etc are the main livestock categories raised for milk, egg and meat. The sustainable livestock strategy aims at reducing the environmental footprint of farms, by improving milk, meat and eggs production, farm profitability, and the well-being of people and animals involved. Integrated farming is the recommended solution for Kerala. Sustainable practises and technological skills will be adopted or adapted along with branding and marketing skills to promote the products of Kerala.

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Long Route Truck Driving – A 360 Degree Review

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Abstract: *Truck drivers are the vital part in any economy as they help us get us the resources, be it raw materials or finished goods. These individuals risk their lives to get these products to the common man but they themselves are denied of certain facilities. They face the extreme weather conditions, uneven road paths and still deliver the goods to the destined place. They face many hurdles on the way to mention a few – robbery, bribe the police and miss their family in this long journey. They face emotional problems like loneliness, not satisfied in their relationships, depression, anxiety among others. Due to this strenuous job the health problems they face are back pain, headache and vision problems. Since they are away from home they depend on the foods that are unhealthy for the body. On the whole this article reviews the overall problems faced by the long route truck drivers. This paper is based on the research articles published on the given topic.*

Key Words: *Truck Drivers, Problems, depression, Awareness.*

Introduction

Most skilled drivers refer to truck driving not as a job, but as a "way of life". The responsibilities go so much further than just holding the wheel and shifting gears and, especially for over-the-road drivers, trucking is not a switch that one just turn off at the end of the day. Dozens of different pieces have to fall into place for one to be successful, and one has to deal with weather, traffic, dispatch, safety, life on the road, etc., and it all falls on one, the driver, to get the job done safely and efficiently.

A truck driver (commonly referred to as a trucker, teamster or driver in the United States and Canada; a truckie in Australia and New Zealand; a lorry driver, or driver in Ireland, the United Kingdom, India and Pakistan) is a person who earns a living as the driver of a truck (usually a semi truck, box truck or dump truck).

Truck drivers provide an essential service to industrialized societies by transporting finished goods and raw materials over land, typically to and from manufacturing plants, retail and distribution centers. Truck drivers are also responsible for inspecting all their vehicles for mechanical items or issues relating to safe operation. Others, such as driver/sales workers, are also responsible for sales and customer service.

The demands, particularly upward of 300 days per year on the road, will certainly limit what time one spend at home, thus impacting relationships with those around one. If an individual is attracted to flexibility, 20 hours of isolation each day, and following a different routine from the rest of the population, then this career is definitely worth exploring.

Methodology

The objective of this paper is to review the articles published in national and international journals and periodicals on the problems of truck drivers across the Globe with special reference to India.

Review Background

Truck drivers have a long history of being held in high esteem by the public. There's an enduring cultural attraction to the 'Knights of the Road. Truck drivers in India have to travel long distances in their lifetime, on an extensive spread of National and State highways that range from well-engineered roads to a complete absence of concrete roads. Their occupation predisposes them to a multitude of risk factors such as prolonged sitting and motor vehicle driving, tight running schedules, reduced rest breaks, traffic congestion, the sedentary nature of job, (Borle A, Agawane S, Gunjal S, Tayde P, 2012) and resultant physical, psychological and behavioral problems. Research on long distance drivers from the Western countries too has established the presence of musculoskeletal and ergonomic problems, stress related manifestations, fatigue and insomnia-related problems, as well as poor sexual and reproductive health (Apostolopoulos Y, et al 2008).

With six million truck drivers in India, the trucking industry represents a notable proportion of the labour force (2.5%). The Indian trucking sector contributes on average 8 lakhs vehicle per annum. But due to the lack of good infrastructure in India there is paucity of truck drivers. Tata Motors, Ashok Leyland and Eicher Motors are major domestic commercial vehicles in India. Truck Drivers are subjected to strenuous long hours of tiresome job and the consequences Often drivers are forced to be behind the wheels for over 15 hours a day (Kumar, Rajkumar, 2015).

The above studies highlight the need to explore the problems of truck drivers in detail which is done subsequently.

Some of the Common Problems faced by the Truck Drivers

Physical Conditions

A large proportion of truck drivers in India suffered from some morbidity and that the prevalence of common problems such as musculoskeletal and visual impairment compared to previous years. Past researches have reported the prevalence of musculoskeletal problems, watering from eyes, cough, breathlessness and dermatological conditions to be 77%, 19%, 25%, 27% and 18%, respectively (Kartikeyan S, et al, 2004).

Shattell, et. al. (2010) stated that majority (76.3%) of interviewed truckers reported one or multiple physical health problems, including musculoskeletal discomforts such as back pain, knee pain, neck pain, and leg and hip problems (16.9%), hypertension (16.9%), diabetes (10.2%), and many also complained of overweight or obesity (8.2%). Mental health problems were acknowledged by 18.7 percent of the truckers. More speciûcally, stress and anxiety were identiûed by 11.9 percent of the drivers interviewed.

Back Pain

Back pain is one of the most frequent trucker problems that arise from doing this job. Most likely they are required to help load and unload the freight. They have to be prepared for this because as they will need to adapt good lifting practices. To avoid injuring the back, they should always bend their knees before picking up or lowering a heavy box, move the box a little to test the weight before lifting. If the box is really heavy, get a tight grip on it and move slow and smoothly - no sudden jerking motions, and not to twist the body during the lift.

Another less obvious cause of back pain is a result of sitting for long hours. As they are constantly working under deadline, there won't be a lot of time for stopping and allowing the body to get some exercise. Truckers spend hours glued to their seat in the same position. Meanwhile, the seat may be bouncing a bit due to the movement of the vehicle underneath. The spine may also take on some wear and tear.

Low back disorders include spinal disc problems such as hernias and spondylolisthesis, muscle and soft tissue injuries. In addition to the normal degenerative aging process, epidemiological studies reveal that poor ergonomic factors in the workplace contribute to low back disorders in a healthy back or accelerate existing changes in an already damaged back. Poor ergonomic work factors increase the load or strain on the back. This may arise from many situations, for example lifting, twisting, bending, awkward movements, stretching, and static postures. Tasks include physical work, manual handling

and vehicle driving where whole body vibration is known. Low back pain is a growing pandemic in the Indian drivers with prevalence 40% to 69% (Kumar 1999). Back pain in truck drivers is of multifactorial such as vibrations, strained postures for long hours, etc, (Laxmaiah 2000). The basic cause of back pain among the truck drivers is the bad condition of the roads.

To protect the back while driving, the drivers should make sure that their seat is well adjusted in the best position for their body. They can also purchase a special seat cushion designed for trucks. Another tip is to stretch the back, arms and legs during breaks to loosen up those stiff muscles.

Dietary Needs

Most of the truck drivers have poor dietary needs, as they drive for long hours on end and your physical health can spiral out of control. Owner operators are constantly under the gun and often don't bother with trying to eat healthier foods.

High calorie, high sugar food can lead to more serious health problems such as diabetes, high blood pressure and chronic digestive ailments. The truck drivers should be sure that they aren't loading down the body with lots of empty calories that don't add anything to overall health and well-being.

Sleep Deprivation

Another taxing issue that a lot of truck drivers deal with is lack of sleep. Again, the pressure to get from one destination to other as quickly as possible meant that truckers are tempted to skip taking a sleep break. Lack of sleep can cause one to experience ailments such as heart disease, irregular heartbeat, diabetes and stroke. Lesser problems are mental fog, forgetfulness, depression, poor judgment, weight gain and reduced sex drive. On top of all that it can make them more prone to accidents (Tully J, 2017).

As you can see, owner operators must always be vigilant about staying in the best physical condition possible. The trucking lifestyle can be very rewarding if they are willing to take care of the mental and physical health. A healthy truck driver is both successful and a benefit to society. Sleep disorders have been linked to a number of generalized health and behavioral disorders, including reduced efficiency while operating a motor vehicle. Globally, thousands of accidents occur due to lack of sleep, tiredness, and fatigue.

HIV/AIDS

National AIDS Control Program III (2007-2012) has given high priority to the truck drivers for the exposure to HIV infection (Park K, 2009). In India, HIV/AIDS has entered into third decade, not as a single epidemic but made up of a number of distinct epidemics. The epidemic shifts from the highest risk groups Commercial Sex Workers (CSW), men having sex with men, and intravenous drug users] to bridge population like clients of sex workers, truck drivers, and migrant population and then to general population (Government of India, 1999). Truck drivers constitute a well-known bridge population for the infection and transmission of HIV/AIDS. Due to migratory nature of work for truck drivers, making them stay away from their families leads to their visiting CSW. Some studies have documented their knowledge and behaviour (Chaturvedi S, et al 2006) There has been a gradual increase in knowledge of truck drivers about HIV/AIDS. Manjunath et al., (2002) conducted a study with the objective to determine the prevalence and pattern of sexually transmitted diseases (STDs) and study sexual lifestyles of long-distance truck drivers and their assistants in south India. It is found that the higher median age, education less than primary school level, longer duration of occupation, longer duration of each trip and a previous history of genital ulcer disease were significant risk factors for the acquisition of HIV infection.

The truck drivers in India lead a life that involves them sleeping for only 2-3 hours a day or taking pills to stay awake. Most of these pills (or as called by them – kali golis) are opium based and addictive. Traffic injuries and fatalities due to loss of sleep and sleep disorders are a growing concern. The main issue is of young truck drivers are vulnerable to crash risk is risk-taking behaviour; speeding, drunk driving with relative failure to include sleep related risk factors.

Psychological Problems

The working conditions of the drivers were rather harsh. During the monsoons the movement of the trucks slow down and the vehicles broke down more often. Apart from the issues caused by the Nature, there are also problems created by the government agencies and local miscreants. The police too demand money for reasons such as non-compliance with respect to vehicle passing, overloading, permits of the vehicle to ply in certain geographies, vehicle condition and the half shading of the head lights. These amounts were reimbursed by the owners, but still dealing with the police is a hassle. The police of certain states created more problems than the rest.

According to Saltzman et al there are heavy truck crashes resulting into the injury or fatality because of adverse environmental conditions (Hansen E S, 1993). From the epidemiological study, it is discovered that truck drivers

face higher risk of death than other men who died from colon cancer, laryngeal cancer, lung cancer, diabetes, ischemic heart disease, non alcohol cirrhosis and motor vehicle accidents (Saltzman G M &, Belzer M H, 2003). It is common understanding on truck drivers who are continuously exposed to various types of pollutants especially air pollutants emitted from vehicles and blowing of horn creates the noise. Gasoline tanker drivers have often experienced acute headaches, dizziness and nausea after exposure to gasoline vapour emitted during loading and unloading.

Traumatic life events are likely to have an impact on long truck drivers just as they might be individuals in other occupational segments, however, the combination of other stressors linked with the transportation environment (i.e., stress, anxiety, depression, loneliness), reduced access to supportive others (family and friends) and to health care providers for mental health promotion and treatment only serves to exacerbate drivers' responses to such events.

Many truckers experience unique and significant occupational stressors that impact their mental health. Truckers' stressors include driving conditions; mental health issues, such as loneliness, boredom, and time away from home; time pressures; fatigue; and perceived negative societal image (Renner, 2004).

Depression is a problem, and, untreated, it can get worse states Mona Shatell, author of several scientific surveys of the mental and physical health of long-haul truckers. According to the Centers for Disease Control and Prevention, truck driver suicide rates are among the top five professions in the country (Olson S, 2015).

Social Problems

Strain in Relations

Being away from the family is not always easy, especially for those who have kids that need to feel his presence. Only few partners can handle this kind of sacrifice. In fact, numerous drivers end up being divorced after joining this career. This career works better for those who are not yet married since after like 6 months to an year of driving experience, one can manage to find an option that will then get home frequently.

Social isolation and inherent difficulties of establishing and maintaining meaningful social ties during long stretches on the road are found to take a toll on drivers' mental health. Truckers struggle with loneliness and are

overstressed from work pressures and weak support systems. Therefore, commercial driving urgently needs policies designed to curb trucking's harmful effects on driver mental health and public safety and occupational therapy programs designed to improve mental health.

The truckers are usually illiterate or people with very little education. Unlike the truckers in developing countries they live in harsh conditions. For instance truckers in the United States sit in an air conditioned unit and drive their trucks. In India it is a totally different situation. One cannot even imagine an air conditioner used by a trucker. The salaries are also very low and they currently range between 10,000-15000 rupees per month. The employers usually provide other means of support to the drivers. They pay for the education of the kids of the drivers. They also help out with the family occasionally since the drivers are almost always out of town working. This usually runs in a very informal manner and it depends on the employer-employee relation.

Truck drivers can spend up to 14 hours driving and battling severe road conditions in a day, receiving roughly 10 hours off before the beginning of the next shift. They have to drive defensively to ensure that they arrive safely, in time, and with the freight being in the right condition. Legislation regulating the amount of hours that a truck driver needs to be on the road per day or per week does exist, but the rules are never followed. They are commonly bent and broken. Even after working for long hours, truck drivers receive one day off work per week. Most people tend to think that truck drivers are handsomely rewarded but if you take into consideration the amount of risk they put themselves into, their pay is low. Their chances of dying are very high with 12% of work related deaths in that are related from truck driving.

Many truck drivers suffer from unstable relationships due to their nature of work. When one starts off as a trucker, getting a job that will allow him to be home regularly is almost impossible. This means that a driver has to be away from the family for days, until they get their time off duty.

Other Problems

Overloading

This a common issue where the truck drivers overloading their truck to increase their profits. But the reality is far from what meets the eye. The gravity of the situation lies in the fact that many truck drivers are merely workers employed by fleet owners, and all they do is follow commands. Now, if a fleet owner asks a truck driver to transport goods via an

overloaded truck, there is not much a driver can do. Additionally, drivers with their own trucks find themselves in situations where the agency hiring them for a particular assignment requires them to deliver the complete load in one cycle.

Overloading is dangerous as it increases the probability of the truck going out of balance and meeting a fatal accident. It is not just the lives of drivers which is at stake but also the lives of other people on the road who might get potentially harmed (Singh YM, 2016).

Awareness to be Created for Truck Drivers

The community has to invest own conscious effort, to solve personal and interpersonal problems, in order to try to master, minimize or tolerate stress and conflict. The effectiveness of the coping effort depends on: the type of stress, the individual and the circumstances. Coping responses are partly controlled by personality (habitual traits), but also partly by the social environment, particularly the nature of the stressful environment.

Some of the techniques to bring about awareness about the healthy lifestyle and improvisation in working conditions which can be incorporated by the truck drivers and employers are;

1. Opportunity for prayer and meditation for acquiring strength
2. Developing healthy eating habits to keep them healthy and stay fit.
3. Understanding the need for exercise and practicing it on a day today basis.
4. Whenever there is a need consulting a physician instead of indulging in self medication.
5. Should often take breaks to keep themselves fit and relax their muscles, so that they can perform even better at their work.
6. Should take a nap if they have night shifts as the journey is too long.
7. Music is another technique which could relieve their stress and make them work with enthusiasm.
8. They should often take break and visit their home and spend time with them which could bring in new energy to work.
9. Technological modification of the vehicle like power steering, GPS system and others may ease the driving and improve the working conditions of truck drivers

Conclusion

The truck drivers play a vital part in our lives. If it was not for them we won't have got our goods delivered at the right time in the stores. To make the life of a truck driver more meaningful he should be included in the social security measures. He should be given insurance by the concerned company who hires him as he too has a family to look after. It is also important to see that the truck drivers have a healthy diet at every stop. It should be seen that there are outlets in petrol bunks for them to refill their trucks as well as they could purchase some healthy snacks for themselves. Therefore, it is important they are looked after by their company for a bright and better prospect in the Indian economy.

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Role of Special Banks in Agricultural and Rural Development - A Study with Reference to Karnataka

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Abstract: *The special banks providing long term Agricultural credit are known as Primary Co-operative Agricultural and Rural Development Banks (initially Land development Banks). The first of this kind of bank was established at Jhang in Panjab in the year 1920. Though, primary Co-operative Agricultural and Rural Development Banks were established dating back to independence, the real growth of these Banks took place only after passing the Land Development Act in the year 1930. These banks were initially called as Land Mortgage Banks as they were financing on the mortgage of Land for which they are used to finance. The Agriculture Credit review Committee in its Report submitted in the year 1989 recommended to incorporate Agriculture and allied activities in its credit policy. But now these banks have included rural credit in its financing policy. Since these banks are playing a greater role in the development of rural area also these banks are now renamed as 'Primary Co-operative Agricultural and Rural Development Banks.*

In this paper an attempt is made to explain the Role of Primary Co-operative Agricultural and Rural Development Banks in India and how these Banks are helping in the economic growth of India.

Key Words: *Special Banks, Rural Development, Land Mortgage, Allied Activities.*

Introduction

Rural development is the process of improving the quality of life and economic well-being of people living in the remote and thinly populated areas. Rural development as a concept suggests the overall development of the areas and sustaining improvement in the quality of life of rural people. It results in an environment which is conducive for improving people's capacity and utilising it to the fullest extent with sustainable basis. It is both the means and end of economic development of a country. Today, apart from governments, rural development has become a matter of interest to industrialists, financiers, bankers and philanthropists as well.

Rural development is needed because of varied reasons such as; to raise the quality of life and environment in rural areas, to minimise urbanization, to manage the natural resources properly, to increase the profits for the farmers.The objectives of the Rural Development Strategies are to increase farm productivity, for achieving rapid economic transformation, to increase household outputs of the selected agricultural products, and to promote value addition and ensure a stable market for these agricultural products.

As per the world bank report (2011), because of four decades of regulations and two decades of liberalization India has become the ninth largest economy in the world, which could grow, second after China, at an average rate of 8.46%, for the last five years. In India there are about 6.4 lakhs of villages with a population of 83.3 crores, which is 68.84% of the whole India. Providing timely and adequate cheap credit to farmers, rural artisans, petty shop keepers, and micro and small entrepreneurs is very important. It is found that rural India suffers from lack of finance comparing to urban India. Therefore rural development strategies are the need of of the hour for an inclusive growth.

Objectives of the Study

1. To study the role of Primary Co-Operative Agricultural and Rural Development Bank.
2. To offer suggestions helpful in solving the problems of the bank.

Methodology

The study is based on both the secondary and primary data. The secondary data was collected from the annual reports of PCARD Bank, Statistical Department of Karnataka, State Co-operative Agricultural and Rural Development Bank. Bangalore. Land Bank Journal, Books.

Limitations of the Study

The present study is an empirical work presented in descriptive manner. Since the objectives of the study may well be met with by this kind of analysis, no attempt is made to provide a conceptual analysis and theoretical framework about Special Banks.

Agricultural Development

The importance of agricultural development is stressed on the ground that 'a sustained growth rate in agricultural output is not only a strong anti-inflationary force, but also makes a favourable impact on income growth. According to the world bank report, 1980, a one per cent increase in agricultural growth in India is correlated with an increase in internal growth of 0.5 percent and national income of around 0.7 percent'. So even in spite of rapid industrialization, agriculture and allied activities constitute the single largest contributor to Gross Domestic Product accounting for almost 33 percent of the total. However, there has been a relative neglect of agriculture and consequent decline in its share in Net Domestic Product. The major cause for this decline appears to be the declining productivity of inputs in agriculture.

Thus, we can observe that, agriculture in spite of its importance suffers from many deficiencies such as lack of value addition process, its dwindling share in Net Domestic Product and the declining productivity of agriculture in general and lack of development of viable organizational mechanism at the grass root level which can undertake planning and co-ordination. This calls for the need to develop the villages at the grass root level which holds the key for economic development.

Agricultural Credit

Since the majority of Indian farmers are poor, credit plays a prominent role. Modernization and rural development requires the provision of cheap finance especially for long periods. The investment credit is of great importance in a capital-scarce country like India. The emergence of Green Revolution and

the new farm technology comprising of high yielding varieties of seeds, fertilizers and the recent policy decision to undertake wasteland development and a forestation have opened new vistas in Agricultural banking. All India Rural Credit Survey Committee (1954) observed that "The credit fell short of the right quantity, was not of the right type and did not serve the right people". The flow of credit to the agriculture sector failed to exhibit any appreciable improvement due mainly to the fact that commercial banks were not tuned to the needs and requirements of the small and marginal farmers, while the co-operatives, on the other hand, lacked resources to meet the expected demand.

Classification of Agricultural Credit

On the basis of time, agricultural credit is classified into short term, medium term and long term. Short term loans are given for a term of one year and are given to meet the day-to-day agricultural requirements of the farmers. Medium term loans are given for periods ranging from one to five years. Long term loans are usually required to meet the capital expenses which are expected to generate returns gradually over a long period. The repayment of long term loan is expected only out of annual net savings of the borrowers. In the case of short term loans, repayment is linked with the harvesting of crops.

Sources of Agricultural Credit

Broadly, there are two sources of credit available to the farmers in India, namely Institutional and Non-institutional sources. Non-institutional sources include the private money-lenders, commission agents etc. who all are detrimental to the interest of rural people. In view of the evil effects of these non-institutional agencies, attempts were made from the very beginning for the provision of cheap credit to the farmers. Institutional credit refers to loans provided to farmers by co-operative societies and co-operative banks including regional rural banks. Among the various institutional agencies, co-operatives were the first to enter the field of agricultural credit. Again, it was identified that, co-operative credit has a great role to play in promoting rural economic development because of its close proximity to local people and knowledge of their living conditions. The commercial banks started to finance to agriculture in 1961 and in 1975 Regional Rural Banks also started to finance agricultural sector to cater the increased needs of the farmers.

Long Term Credit

After the advent of co-operative movement in India there raised the need for a specialized institution satisfying the long term financial requirements of the farmers. In long term credit, a number of difficulties are associated like locking up of funds for long periods, risks involved in lending money for long period etc. All these forced the planners of Indian economy to establish a separate financial Institution. Again the repayment period of long term loans is spread over a number of years, therefore, mortgage requirements has been considered as an essential requisite for such long term loans. Keeping these points in view creation of a new specialized institution was thought of. Thus Land Mortgage Bank was formed; catering to the complicated term loans of the farmers in India. Later these banks were very popular as Land Development Banks. Since these banks are playing a greater role in the development of rural area also, these banks are now renamed as 'Primary Co-operative Agricultural and Rural Development Banks.

Structure of the Bank

These banks have two tier structures. At the central level that means at the state level there is Central Rural Development Banks which are now called as State Cooperative Agricultural and Rural Development Banks (SCARDB). And at the Tuluka level Primary Cooperative Agricultural and Rural Development Banks (PCARDBS). In some states, there are no primary land development banks but in their place, there are branches of central land development banks.

Raising Funds

The main function of raising funds is carried out by the Central or State Cooperative Agricultural and Rural Development Banks which can really deal with the money market of the country effectively and advance loans to primary Cooperative Agricultural and Rural Development Banks. The sources of funds of State Cooperative Agricultural and Rural Development Banks are:-

1. Share capital
2. Issue of debentures
3. Loans from NABARD
4. Reimbursements of subsidies from the Govt.
5. Other funds.

Issue of debentures is the main source of funds for the Cooperative Agricultural and Rural Development Banks. Debenture is a 'Bond' conveying and acknowledging the debt and also containing the provision of promise for payment of interest at stipulated rate and return of the principal amount. The period of debentures varies from 7 to 15 years. As Cooperative Agricultural and Rural Development Banks require funds of longer duration to advance long term loans to borrowers, the debenture is a convenient instrument of raising funds. Because it guarantees that funds will remain with the Banks for a specified period.

These debentures are mostly purchased by financial institutions like LIC, Commercial Banks, Co-op. Banks, NABARD, and State Governments. As there is limited response from the public. The State Government gives incentive subsidies for many development activities by individual farmer including purchase of tractor. The amounts of subsidies are reimbursed to the Primary Cooperative Agricultural and Rural Development Banks.

Deposit Mobilisation

To strengthen the resource base of SCARDBs, RBI has granted permission for accepting rural deposits from the borrowers/non-borrowers of SCARDBs in rural areas. SCARDBs have formulated their various deposit mobilisation schemes and are accepting deposits ranging from one year onwards.

Interest Rate

The rates of interest for long term Loans are generally low and within the paying capacity of farmers. They are around 9 to 12%.

Loan Procedure

The Branch offices receive applications from the prospective borrower. Then Agricultural Finance Officer or Inspector scrutinises these applications, they visit places of the application and ascertain the purpose of borrowing, verify the genuineness of the proposal and its economic viability, repaying ability of the farmers, adequacy of security, etc. After completing those formalities, the loan is granted by the appropriate authority at appropriate level depending upon the delegation of powers by the Banks.

Role of PCARD Bank in Economic Development

The rural population in India was suffering from agricultural indebtedness and was subject to exploitation in the credit market with high rates of

interest and lack of convenient access to credit. Rural household was in need of credit for investing in agriculture and smoothening out seasonal fluctuations in earning. Thus there was the need of a financial institution which could provide credit at lower rates and at reasonable terms than the traditional money-lender. To solve this problem PCARD Bank, which are also known as special banks were established.

The Primary Cooperative Agricultural and Rural Development Banks provide long-term loans to the agriculturists for permanent improvements on land. They usually charge 9 percent interest. They grant loans against the security of land or other agricultural property. Loans are usually given on the first mortgage and sometimes even on the second mortgage of land or agricultural property. Generally, they give loans up to 50 percent of the market value of the mortgaged property.

The Primary Cooperative Agricultural and Rural Development Banks meet the requirements of the farmers for developmental purposes viz., provision of equipment like pump-sets, tractors and machinery and land improvement in the form of levelling, bundling, reclamation of land, fencing, digging of new wells and repairs to old wells, Loans are granted on the security of mortgage of immovable property of the farmers.

The Central Cooperative Agricultural and Rural Development Banks raise their resources by floating debentures in the market. These debentures carry the guarantee of the State Government and are subscribed by the Central and State Governments, Commercial Banks, Life Insurance Corporation and other Land Development Banks as a measure of mutual support. The Primary Cooperative Agricultural and Rural Development Banks have availed of the refinancing facilities provided by the National Bank for Agricultural and Rural Development in respect of the term loans granted by them for the schemes of agricultural development. They also secure short term accommodation from the State Governments, Commercial Banks and the State Co-operative Banks.

Credit Delivery

The Role of Primary Cooperative Agricultural and Rural Development Banks in the economic development of the country can be understood with the study of various types of loans and credit facilities offered by these Banks.

The Primary Co-operative Agriculture and Rural Development Banks grants long term loans to the farmers against the conveyance of land as security. The progress made by these banks is seen in the growth of number of banks

and increase in the number of membership. *The economic and social well-being of the borrowers is also identified as one of the objectives of the lending by PCARDBs. Supply of adequate credit can stimulate agriculture operations and rural development to a great extent.* Till recently, the short term financial requirements of the farmers such as crop finance, demand loans, Agricultural advances were not in practice. The Primary Co-operative Agriculture and Rural Development Bank have started these schemes thus helping the farmers to meet their short term financial requirements also.

Generally PCARDBs provide both Farm and Non-farm loans i.e., loan for minor irrigation, farm mechanization, sericulture development, horticulture and plantation, Diversified scheme, Non-farm Sector and Rural Housing. The following types of loan facilities are available to members of the Bank.

1. Agricultural Loans

1.1 Minor irrigation Projects like Construction of new Wells, Repairing of existing wells, Construction of Water Tanks and Sprinkler irrigation purpose etc.

1.2 Special Projects like Development of Areca Plantations, Development of Coconut and Rubber Plantations, Rubber Processing Unit, Areca nut Dryer Construction, Fencing around the Plantations, for the construction of new Rubber, Coconut and Cashew nut Plantations.

1.3 Variety Projects like Financing Small and very small Farmers for the purchase of Agricultural, Poultry farming, Dairy farming, Gobar Gas unit, for the Purchase of power Tiller and Tractors and Purchase of two wheeler (only to farmers)

2. Non-Agricultural Loans

2.1 Small Scale and Service Industries

2.2 Purchase of Light Transport Service Vehicles

2.3 Repairing, Extension and Construction of new houses in the villages.

Table 1: Trends in financial performance of the KSCARDB

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	CGR%
Membership	184	184	184	184	182	-0.21
Owned Funds	9717.89	6746.25	6125.89	7005.91	7851.72	-3.81
Deposits	4137.19	4515.26	4068.65	4109.49	4285.02	-0.23
Borrowings	126043.58	118806.23	124785.04	132150.89	146639.89	4.17
Working Capital	134513.96	160288.81	166867.89	154358.88	183393.80	5.99
Advances	11913.90	17731.48	25086.86	21043.21	17764.39	10.18
Recoveries	57789.36	66717.00	32299.48	12164.56	20343.66	-31.54
Loans outstanding	133998.36	120302.12	126761.98	126914.65	133291.67	0.43
Over Dues	40012.04	38444.36	27302.16	41423.54	46193.72	3.68

Source: Statistical Report of KSCARD Bank Ltd., Bangalore

Table 1 Indicates the trend in performance of Karnataka State Co-operative Agriculture and Rural Development Bank (KSCARDDB). For the period from 2011 – 12 to 2015 -16 the owned funds, deposits, recovery showed the negative compound growth rates of 3.81 percent, 0.23 and 31.54 percent respectively. The amount of borrowing, working capital, advances, loan outstanding and over dues showed compound growth rates of 4.17 percent, 5.99 percent 10.81 percent, 0.43 percent and 3.68 percent respectively.

There has been a striking progress in advances and working capital. However, the indicators such as owned funds and recoveries are unsatisfactory

Table 2: Trends in Scheme – wise Advances of the KSCARDB

Schemes/Purposes	2011-12	2012-13	2013-14	2014-15	2015-16	CGR%
Minor Irrigation	3473.32	5161.50	7505.10	4918.75	2400.59	-7.56
Horticulture	1692.40	2326.74	2773.78	2099.86	1211.31	-7.42
Sericulture Development	240.24	483.48	1431.59	1220.48	555.14	29.70
Diversified Activities	1012.64	1879.16	2659.81	2619.02	1336.92	9.28
Farm Mechanization	2139.33	3736.72	8054.80	8718.77	1131.46	-4.17
Non Farm Sector	462.20	434.61	424.52	311.14	42.42	-40.01
Rural Housing	2883.59	3708.16	2192.97	1152.52	269.11	-44.63
General Schemes	153.00	007	020	030	057	-5.06

Source : Statistical Report of KSCARD Bank Ltd., Bangalore

According to the above table scheme wise advances of Karnataka State Co–operative Agriculture and Rural Development Bank (KSCARDB) for the period from 2011-12 to 2015-16 the loan issued under sericulture development had a compound growth rate of 29.70 percent followed diversified activities with compound growth rate of 9.28 percent. Further, the schemes like minor irrigation non-farm sectors, rural housing and other schemes showed a negative compound growth rate.

Table 3: Operational Efficiency of PCARDBs in Karnataka

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	CGR%
Membership	1034513	1037635	1050757	10828832	1100374	1.67
Owned funds	30631.75	24940.64	25902.73	26747.85	28055.54	-1.05
Deposits	7890.90	7312.98	6891.33	6959.20	7593.55	-1.27
Borrowings	139655.55	121134.61	129034.15	130339.48	133585.97	-0.15
Working capital	133346.43	120741.97	138509.98	143687.24	151560.92	4.39
Advances	16002.75	22653.17	29366.48	25767.12	22711.07	8.64
Recoveries	117500.91	66717.00	3025.42	24029.30	29934.19	8.86
Loans outstanding	119902.97	103552.68	114156.26	122448.26	123561.03	2.30
Over dues	69497.13	38444.36	33970.13	38429.87	38885.63	-10.96

Source: Statistical report of KSCARD Bank Ltd., Bangalore

Progress Report of KSCARD bank Ltd., Bangalore.

Table 3 indicates that the operational efficiency of primary co operative agriculture and rural development banks in Karnataka. For the period from 2011-12 to 2015-16 the membership working capital advances, recoveries and loan outstanding showed the compound growth rate of 1.67 percent 4.39 percent, 8.64 percent, 8.86 percent and 2.30 percent respectively. Growth of owned funds, deposits and borrowing showed negative compound growth rate respectively. However, the indicator of recovery is satisfactory.

Table 4: Trends in Scheme Wise Advances of PCRDBs

(Figures in Rs. Lakh)

Schemes/Purposes	2011-12	2012-13	2013-14	2014-15	2015-16	CGR%
Minor Irrigation	26312.69	13238.52	10895.06	11766.55	10779.14	-17.32
Horticulture	8975.19	5358.38	4675.37	6607.86	6750.94	-3.53
Sericulture development	3306.12	1340.89	1328.13	1472.80	1575.79	-12.96
Diversified activities	6249.24	3642.10	2988.12	3372.29	3209.34	-13.14
Farm Mechanization	9536.11	4738.44	4667.75	4897.15	4875.67	-12.27
Non Farm Sector	6590.86	4737.92	3962.05	3861.76	3383.53	-14.25
Rural Housing	2446.26	2436.32	2872.55	2879.16	4038.68	12.42
General Schemes	4656.79	2055.07	1421.00	1549.49	1904.31	-18.70

Source : Statistical Report of KSCARD Bank Ltd., Bangalore

Progress Report of KSCARD Bank Ltd., Bangalore.

Note CGR = Compound Growth Rate

The table 4 depicts the loan issued under different schemes by Primary Co-operative Agriculture and Rural Development Banks in Karnataka for the period form 2011-12 to 2015-16, the loan issued under rural housing had a compound growth rate of 12.42 percent. Then loan issued under minor irrigation showed negative compound growth rate of 17.32 percent followed by horticulture, sericulture, diversified activities, farm mechanization, non

farm sector and general scheme with negative compound growth rates of -3.53 percent, - 12.96 percent, 13.14 percent, -12.27 percent, -14.25 percent and 18.70 percent respectively. However, the loan issued under minor irrigation, sericulture, diversified, farm – mechanization, non farm sector and general schemes are not satisfactory.

Findings and Suggestions

Land Development Banks in India are of quasi-commercial type. Although they are all registered under the Co-operative Societies Act, they are associations of borrowers as well as non-borrowers organised on the principle of limited liability. The borrowing capacity of a member is generally determined according to the number of shares he holds in the bank, though each member has only one vote according to co-operative principle, irrespective of the number of shares he holds.

The PCARD Banks made tremendous progress in India. Many states are having Primary Co-operative Agriculture and Rural Development Banks. These banks, through their special schemes help the farmers and thus assist in the process of economic development of the country. Though these banks are striving hard in the socio-economic up-lift of farmers, the following defects have been noticed in the working of PCARD Banks.

1. Loans given by them are predominantly for discharging of prior debts and not for purpose connected with land improvements.
2. These banks do not have the necessary specialized staff for assessing the technical soundness of scheme. Although State Government possesses such staff, there is no co-ordination between them and the PCARD Banks.
3. These banks do not prescribe different periods for different types of loans.
4. They are not able to raise sufficient funds although their debentures are guaranteed by the State Governments.
5. There is no co-ordination between the activities of State Co-operative Bank and the Primary Co-operative Agriculture and Rural Development Banks.
6. Delay in Granting loans.

It is suggested that before sanctioning loans the purpose for which loan is borrowed is to be studied by the bank. Fresh loans are to be sanctioned only after clearing the old loans. An investigation has to be conducted by the responsible officer connected with the Bank to assess the soundness of the scheme.Guidance of the technical expert has to be obtained in this connection. One of the serious drawbacks of this bank is scarcity of fund. Therefore steps must be taken to raise funds for the disbursement of funds.

Conclusion

It may be noted that **t**he Primary Co-operative Agriculture and Rural Development Banks have made commendable progress in quantitative terms but they are suffering from high overdue due to poor recovery and heavy accumulated losses. The need of the hour is to increase the recovery to improve the financial strength of the banks and to render good services to the people on a developing country like India.

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