Achieving Zero Hunger vis-à-vis Role of Extension Agencies

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Abstract- **In most of the developing countries of the world, a majority of population directly or indirectly depends on agriculture for its livelihood. There is manifold increase in agriculture production after green revolution in our country. India now ranks third in total cereal production, first in pulses production and first in milk production in the world (Anonymous, 2022). Despite this, the problem of food insecurity and malnutrition is still prevalent in the country. Globally, 148 million children are stunted, and 45 million children were found effected by wasting under the age of five years with a high prevalence in Asian and African countries. In India, Bihar, Jharkhand, and Meghalaya have the most stunted children and wasting has been generally observed most prevalent in Gujarat, Maharashtra, Bihar and Jharkhand. Despite sincere government efforts to mitigate the problem of hunger and malnutrition, most of the main problems like poverty, food wastages and loss, hidden hunger, conflicts between and within countries, poor distribution system, climate change and natural disasters etc. are coming in the path which needs to be urgently addressed. The government has taken several initiatives in the form of National Food Security Act, Poshan Abhiyaan, PM Poshan Sakti Nirman, National Food Security Mission besides certain apps like Share the Meal app, Aahar app and Olio app working at national and international level for ensuring food security in the country besides the concepts of Nutrition Smart Villages, Biofortification, balance diet and emphasis on sustainable agriculture are good steps in this direction. The extension agencies working at the grass root level can play a significant role in creating awareness about nutritious balance diet, malnutrition, biofortified crops, organic farming, sustainable agricultural practices and integrated nutrient and pest management besides dissemination of improved farm technology to the farmer fields.**

Key words: **Food Security, Sustainable Agriculture, Awareness, Biofortification, Malnutrition, Extension agencies etc.**

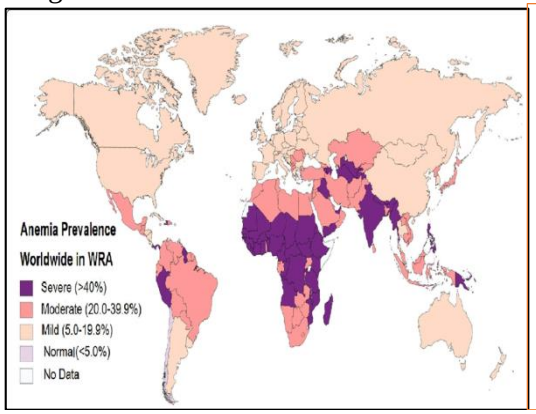
In most of the developing countries, a majority of population derives their livelihood from agriculture sector directly or indirectly. Livelihood is defined as adequate stock and flow of food and cash with an individual or a family to meet its basic needs (Acharya, 2012). After green revolution, the agricultural sectors had bloomed magnificently. The food-grains production in India has increased to 285.71 million tonnes with milk production of 210 million tonnes, horticulture production of 342.33 million tonnes and fish production of 16.24 million tonnes in 2021-22. India ranks third in total cereals production, first in pulses production and first in milk production in the world in 2020 (Anonymous, 2022). It was a marvellous change in India's conditions becoming a major producer of agricultural commodities from the times of dependency on other countries. But the problem of food insecurity and malnutrition is still prevalent and has become a major issue worldwide. Food insecurity causes hunger among humans as well as animals causing malnutrition. Hunger causes various forms of malnutrition affecting the human body both physically and mentally. It negatively affects the psychomotor skills, learning power, memory, mental retardness etc. In 2022, around 9.2 percent i.e. 735 million people were facing the chronic hunger problem, and an estimate of 30 percent people were moderate to highly food insecure (Anonymous, 2023). It is estimated that one in three people is facing moderate to severe food insecurity worldwide. This is such a concerning issue because around 2 billion people do not have access to safe, sufficient, and nutritious food worldwide. But it does not mean the world is not doing anything to solve it. The Sustainable Development Goals (SDGs) came up in the United Nations Conference at Rio De Janeiro 2012 summit after the Millennium Development Goals (MDGs). The MDGs started in 2000 by the United Nation with seven goals which later became the base for present SDGs. The SDGs were adopted on 25 September 2015 with 17 goals titled "**Transforming our world: The 2030 Agenda for Sustainable Development**" covering economic, social development, and environmental aspects with a view of shared peaceful and prosperous future signed by 193 countries. One of the major goals is SDG-2 "**Zero Hunger**" i.e. **achieving food security and improved nutrition**

and promoting sustainable agriculture. Zero hunger means availability of food both in qualitative and quantitative terms with the objective to end all forms of malnutrition. It aimed eight targets as given below:-

2.1- Universal Access to Safe and Nutritious Food
2.2- End All Forms of Malnutrition
2.3- Double the Productivity and Incomes of Small-Scale Food Producers
2.4- Sustainable Food Production and Resilient Agricultural Practices
2.5- Maintain the Genetic Diversity in Food Production
2.a- Invest in Rural Infrastructure, Agricultural Research, Technology and Gene Banks
2.b- Prevent Agricultural Trade Restrictions, Market Distortions and Export Subsidies
2.c- Ensure Stable Food Commodity Markets and Timely Access to Information

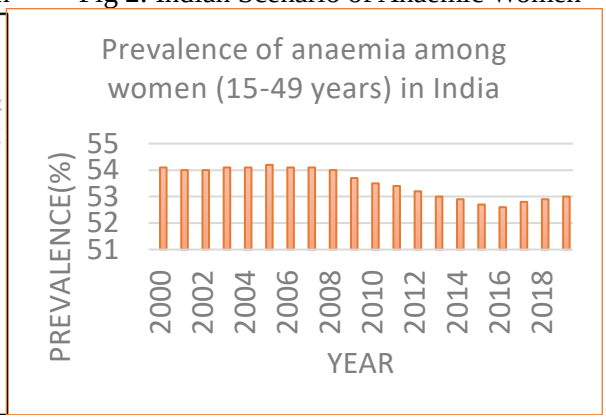
The targets of zero hunger are closely inter-related with other SDGs such as SDG-1: No Poverty, SDG-3: Good Health and Well-being, SDG-4: Quality Education, SDG-5: Gender Equality, SDG-6: Clean Water & Sanitation, SDG-7: Affordable & Clean Energy, SDG-8: Decent Work & Economic Growth, SDG-10: Reduced Inequalities, SDG-12: Sustainable Consumption & Production and SDG-13: Climate Action. The zero-hunger mission is tracked through indicators like prevalence of undernourishment, food insecurity, prevalence of stunting and wasting among children under 5-year age, prevalence of anaemia among women in the age group of 15-49-year age etc. The total population facing hunger and food insecurity has risen in the last few years because of pandemic, climate change and conflict between countries. Severe prevalence of anaemia (>40%) was reported among women in African countries like Somalia, Chad, Sudan, Niger, Mali, Kenya etc. and among Asian countries in India, Nepal, Bhutan etc (Fig 1). In India, there is still an alarming rate of anaemia among women from 54 percent in 2000 to 53 percent in 2019 (Fig 2). Why has the anaemia prevalence not decreased even after two decades in India? Is there any problem in implementing the policies or the people are not aware of it? These questions need to be answered to fully understand this persistent problem.

Fig 1: Global Scenario of Anaemic Women



Source: Menshawey *et al.*, 2020

Fig 2: Indian Scenario of Anaemic Women



Source: FAOSTAT, 2023

Similarly, 148 million children are stunted, and 45 million children are affected by wasting among children under 5-year age in the world with a higher prevalence in Asia and African countries in 2022. The stunting prevalence was found to be 1.6 times higher and wasting prevalence 1.4 times higher in rural areas when compared with urban areas mainly due to difference in access to health care, water, sanitation, and hygienic environment. Stunting is related to chronic or long-term malnutrition while wasting refers to weakened immunity and current status of malnutrition. Though stunting has decreased from 26.3 percent in the year 2012 to 22.3 percent in the year 2022 in children under the age of five years, yet it is still a big number (FAO, 2023).

In India, Bihar, Jharkhand, and Meghalaya have the most stunted children and wasting is generally most prevalent in Bihar, Gujarat, Maharashtra, and Jharkhand. Some of the states were able to decrease the prevalence of stunting and wasting while there were still many states where these had increased like Himachal Pradesh, J & K, Telangana, Tripura, Mizoram etc. (PIB, 2023).

To monitor the status of zero hunger and other SDGs and the approaches used to counter them in the world, each country gives a Voluntary National Review (VNR) report to the UN regarding their national level performance each year. In India, NITI Aayog monitors the performance of each state and Union Territory (UT) to provide VNR to the UN. It places the states and UTs among four categories viz; **Aspirant (0-49), Performer (50-64), Front Runner (65-99) and Achiever (100)** according to their performance score in the SDG Index annually. According to NITI Aayog SDG Index & Dashboard 2020-21, Kerala is the top state and Chandigarh is the top union territory in their performance towards SDG-2 with Chandigarh as overall top performer. Bihar and Jharkhand are the bottom two states

in the Aspirant category, though none of the state/UT has achieved the status of Achiever. There is no doubt that the government is making every effort to mitigate the problem of hunger and malnutrition but there are certain obstacles in the path which need to be addressed first. Some of the major barriers/bottlenecks are being discussed as under:-

- **Poverty-** As per the report of NITI Aayog, 2021, 23% of the total population lives under National Poverty Line in India. The people living in poverty do not have regular and good quality food access because of high prices of food commodities and constant change in inflation. There is an overall 5.5 % inflation rate in the India with some countries having inflation of 29% in Ethiopia, 121.7% in Argentina, 29% in Pakistan, 360% in Venezuela etc. (IMF, 2023).There was an increase of 8.6% in food prices (September 2022) in India, the biggest ever since November, 2020 along with vegetables (18.05%), spices (16.88%), cereals (11.53%) recording the highest rise in 9 years (NABARD, 2022). The low income with low purchasing power and poverty forms a vicious cycle of poor nutrition among these people.
- **Food wastage & loss-**According to Irani *et al.*, (2018), food loss refers to the loss in the initial supply chain of food i.e. from planting to the processing stage while food waste occurs in the later stages generally caused by the consumers due to their behaviour. According to an estimate Xue *et al*. (2022), 24% of food is wasted during production, 24% during harvesting, and 35% while consumption, thus, constituting approximately 80% of food wastage during these three stages. Dabbene (2014) studied the problem of food wastage in Indian context and concluded that low adoption of scientific practices by the famers at the harvesting stage and many intermediaries in between are the major reasons for food wastage. The food wastage occurs because of inadequate transportation, lack of scientific storage, proper containers unavailability during packaging and handling etc. Among south Asian countries, the highest amount of food is wasted in Afghanistan i.e. 82 kg per person per annum followed by Nepal 79 kg, Sri Lanka 76 kg, Pakistan 74 kg and Bangladesh 65 kg while India is at the bottom in terms of food wastage, but the figure is still high i.e. 50 kg.
- **Hidden hunger-** Though the agriculture focus has shifted more on increasing productivity of crops, profitability of farmers and agro-based industries resulting in input-intensive agriculture, but the nutritious crop harvest and importance of soil fertility were entirely forgotten. Our diets rely on only a few crops making it simpler and somewhat homogeneous everywhere. According to FAO Publication (1995), 60 percent of world's food energy intake is provided by rice, wheat and maize (Ginkel and Cherfas, 2023) which has resulted in micronutrient deficiencies such as iron, zinc, vitamins etc.-commonly known as hidden hunger. A person who is eating all the meals does not mean that he/she is taking a healthy nutritious diet. From the last decade, the fast-food has taken a big portion of our daily diet and is one of the main reasons for hidden hunger. In fact, anaemic soils breed anaemia in human beings. During crop production, if the nutrient management is poor and crop plants do not take up sufficient nutrients, then the harvested crop will have low availability of nutrients which ultimately consumed by us would be another major reason for hidden hunger. Similarly, when less nutritious fodder is fed to the livestock, it would result in less nutritious milk. This is the biggest reason as why a significant portion of the population falls under malnutrition even if the agricultural production has increased manifold.
- **Conflicts between country and within country-** The recent conflict between Russia and Ukraine is a good example, both the countries had 30% share in wheat and barley, one-fifth in maize and around half in case of sunflower oil in the world. About one-third of their wheat was imported to 45 African and least developed countries of the world (Guterres, 2022). But now the war has disrupted the food supply chain resulting in inflation these countries. In the beginning of 2022, inflation in wheat and maize increased by 30% negatively affecting the people inside and outside Ukraine throwing them into poverty, inequalities and a large scale of hunger.
- **Poor distribution system-** The government has started many programmes for the distribution of food-grains to the needy persons because of which the prevalence of malnutrition has decreased but not very much. So, the question is what could be the problem? Whether there is a proper check on the distribution centres or not is required to be probed to find the right nutritional status of the people in the defined area.
- **Climate change & disasters-** Climate change is a man-made phenomenon which is affecting the agricultural sector in a great deal. The average global temperature has risen by 0.8^0C in the last century and is expected to further rise by an addition of 1.5-4.8^0C in the next century (Chouhan *et al.*, 2023). According to team constituted by FAO, each 1^0C rise in mean temperature results in loss of about 6 million tonnes of wheat yield per year in India (Swaminathan, 2012). Have we ever heard of floods in Rajasthan? NO! Have we ever thought the consequences of human activities of burning fossil fuels, release of greenhouse gases to the environment and agriculture? Have we ever thought climate change may be the reason for droughts, floods, increase in disease incidence in crops, crop failure etc. which we call natural disasters? - probably not. Similarly, El Nino phenomenon occurrence is affected by climate change which affects the Indian monsoon causing drought conditions. The reason for delay of 2023 monsoon in India is because of El Nino. Rise in temperature leads to higher evapo-transpiration losses increasing demands for irrigation. Furthermore, it affects the soil, livestock production, pest incidence in the crop, biodiversity, fishery etc.

Adverse Effect of Covid-19 on Food Supply Chain:-

The outbreak of covid-19 pandemic had affected not only India but the world as a whole. The national lockdown disrupted the food supply chain affecting availability, price, and quality of food. We have seen in the news of farmers throwing their produce in the streets as there was no demand on the behalf of hotels, restaurants, schools etc. It also resulted in many people losing their jobs causing household food insecurity. The percentage of population living in moderate and severe food insecurity increased from 27.3% to 37.5% in Latin America and Caribbean, 17.7% to 24.2% in Asia and 45.4% to 60.9% in Africa with an overall increase from 21.7% to 29.6% in the world from 2015 to 2022 year (FAO, 2023). The pandemic added more people under food insecurity and poverty.

Some of the Major Initiatives Taken by Government Of India:-

Our government has taken the following initiatives for food security in the country:-

a) **National Food Security Act (NFSA), 2013:** The schemes before NSFA were focussed on welfare of its people but now it has shifted to rights-based approach. The central govt. provides foodgrains supply through Food Corporation of India (FCI). FCI procures the surplus food-grains from the farmers and then stores them in godowns for further supply to the state governments. Each state government is responsible for the implementation and distribution of food grains through Public Distribution System (PDS) under different schemes. It covers 75% of rural population and 50% of urban population. Under the Antyodaya Anna Yojana (AAY), poorest of the poor people are covered who are entitled to get 35kg food-grains per family per month while under Priority Households, 5kg food-grains per person per month are allotted. As per comprehensive ranking for NFSA implementation (2022), Odisha state was ranked no.1 followed by Uttar Pradesh and Andhra Pradesh with Himachal Pradesh ranked 11th while Manipur, Meghalaya and Ladakh were put at the bottom in the list respectively (MoCAFPD, 2022).

b) POSHAN Abhiyaan- Erstwhile called National Nutrition Mission launched on International Women's Day- 8th March, 2018 at Rajasthan to eliminate malnutrition by the year 2022. The programmed aimed to achieve improvement in nutritional status of children from 0-6 years, adolescent girls, pregnant women and lactating mothers in time bound manner with reduction in stunting, wasting and anaemia among women and girls. The country celebrates Rashtriya Poshan Maah in September every year to create awareness about the role of nutrition required for the proper functioning of a human's body. The NITI Aayog has to submit six monthly reports of implementation besides mapping several other schemes such as Janani Suraksha Yojana, Matru Vandana Yojna, National Health Mission etc. Though Poshan Abhiyan is a centrally sponsored scheme, yet its implementation is done by the States/Union Territories. It is also ensured that all Anganwadi Centres must be equipped with Smart phones and Growth Monitoring Devices (GMDs) such as Infantometer, Stadiometer, Weighing scale etc. for mother and infant.

c) **PM Poshan Shakti Nirman-** Popularly known as mid-day meal scheme which provides free mid-day meals to primary and upper primary classes in government and government-aided schools. It was launched on 15 August 1995 to eradicate malnutrition and simultaneously encourage students' school attendance. As per the food norms 450 calories and 12g protein is provided to primary classes and 700calories and 20g protein requirement to the upper primary classes. Although, the menu varies from state to state but generally it consists of cereals, pulses, vegetables, oils and fats.

d) **National Food Security Mission (NFSM)-** It was started on October, 2007 to increase annual production of rice by 10 million tonnes (Mt), wheat 8Mt and pulses 2 Mt through area expansion and productivity enhancement by the end of the 11th five year plan (2011-12). The scheme was launched in response to the recommendation of the agriculture sub-committee- a component of National Development Council (NDC). Coarse cereals were included in the mission under NFSM in 2014-15. NFSM includes the National Mission on Oil Seeds and Oil Palm (NMOOP) to increase the availability of vegetables oils and reduce the import of edible oils. The mission continued during the 12th five-year plan with new targets of additional food grain production of 25Mt consisting of 10Mt rice, 8Mt wheat, 4Mt pulses, 3Mt coarse cereals by the end of the 12th plan. Based on past experiences and performance of the 12th plan, it has been decided to extend the programme till 2019-20 with new targets to achieve additional 13Mt of foodgrains, comprising rice (5Mt), wheat (3Mt), pulses (3Mt) and coarse cereals (2Mt) by the end of year.

e) **Share The Meal App-** A charity app initiated by UN World Food Programme (WFP) with the motive of "**Share more, Waste less**". It was launched as a pilot project in July 2015 in Germany, Austria and Switzerland which was extended to the whole world by November 2015. The app is available in nine languages and in 27 currencies and so cheap that even 50 cents can feed a kid for a day. The users can also invite his/her friends and others through 'Facebook' to join him/her on this platform. Hence, users can access and make payments anytime and anywhere with the transparent system to monitor the progress of their funds to whom they are giving. It was among the Google's Best Apps of 2020 in the category of 'App for Good' and also won 2020 Noble Peace Price.

f) **Aahar App-** This app was started by Mr. Sanjay Dubey- Principal Secretary, Energy, Government of Madhya Pradesh, Bhopal in October, 2016. It is being used in more than 53 cities serving in three modes viz; **surplus food, fresh food and packed food**. Surplus food prepared during functions/social gatherings can be donated which is collected with the help of NGO's, fresh food prepared by contributing in cash at selected locations can be donated to feed hungry people and packed food nearing expiry date can be advertised to be sold to the consumers at discounted

price. Aahar app had helped in saving around one lakh kg of food in 2017 year that would have otherwise been wasted and could pollute the city's environment. The app has become a medium for feeding more than one million hungry stomachs till date.

g) **Olio app**-This app was created by two friends namely Tessa Clarke and Sasha Celestial in the year 2015 with one mission to create a world in which nothing of value goes to waste. Its motive is '**Give it away and make someone's day- let your useless become someone else's useful**'. It takes help of local shops, cafes and individual users to share leftover food. It not only deals with food items but also non-food items unlike other apps. The olioers share clothes, technology, books, kitchenware and even furniture that they no longer need. To donate the items first of all, look around you. Notice the things you have. Appreciate the things you need and pick out the things you don't need. Next take a photo. Add each item to the app and wait for someone to request and collect them. Lastly, keep looking around you and ask: "If it isn't useful for me, could it be useful for someone else?

Nutrition Smart Villages:-

To commemorate the 75 years of Independence of India, Nutrition Smart Villages (NSV) programme was initiated by our Prime Minister as part of Azadi Ka Amrit Mahotsav to strengthen the Poshan Abhiyan. Under this programme, 75 villages across India were selected through the network of All India Coordinated Research Project on Women in Agriculture (AICRP-WIA) and was in operation at 13 centres in 12 States of India (Drishti IAS, 2021). It is a multi-sectoral approach to strengthen nutrition and food security in rural areas working on three levels viz; **making agriculture nutrition sensitive** (not only consumption of wheat and rice, but also pulses, millets etc.), **promoting Traditional Knowledge** and **creating awareness and educating them** (To change their behaviour). The selected villages were informed about importance of nutrition, the facilities available and how to improve them. There is major five practices followed under NSV:-

- **Organizing Nutrition Camps**: Screening for under-nutrition in children (6-36 months old), followed by capacity building of mothers of the malnourished children on infant feeding, hygiene and care practices. All these activities-based sessions were for maximum 15 days.
- **Sustainable Integrated Farming System (SIFS):** Developing home-based nutrition gardens focusing on integrating crops-trees-aquatic system-bird-livestock so that all the resources are optimally used to increase dietary diversity, reduce cost in food production, consume safe food, and increase income through marketable surplus such as kitchen gardens.
- **Linking Agriculture and Natural Resource Management towards Nutrition Security (LANN)**: Facilitating Participatory Learning Approach (PLA) based meeting cycles to sensitize/aware communities on the immediate, underlying and basic causes of malnutrition. The knowledge and skills acquired through the meetings support the community to plan, take actions, and evaluate the status of food security in the village in terms of availability, access, utilization, and stability of food.
- **Nutrition Sensitive Micro Planning (NSMP):** It is a way to bridge the gap between problems and solutions with govt. policies and schemes aim to ending hunger and poverty. It is a decentralized process in which sensitized families are helped to plan the use of their resources to maximize food production, maintain personal and environmental hygiene and demand legal entitlements.
- **Strengthening Institution:** Support village institutions, Self Help Groups (SHGs) and local committees to be informed, skilled and enabled to monitor the good practices, make service providers accountable and help people access their rights.

Bio-Fortification:-

Bio-fortification is the process of increasing the density of vitamins and minerals in a crop through plant breeding, transgenic techniques, or agronomic practices. The availability of micronutrient rich non-staple food such as pulses, vegetables, fruits and animal products are very less to feed the whole population resulting in high prices of these food items. Not everyone is able to purchase these food items and relies on the staple food crop as they are much cheaper and affordable to many. Therefore, bio-fortification is a key to counter the hidden hunger within the current scenario of our food diet. It is also a feasible measure to reach the rural population to improve their nutritional status.

Consultative Group of International Agricultural Research (CGIAR) is doing the job of promoting bio-fortified crops worldwide through HarvestPlus- one of its components. HarvestPlus works on bio-fortification of crops in iron, zinc and vitamin A, collaborating with the CGIAR institutes, researchers and NGOs to breed bio-fortified varieties and their delivery to the needy. It has produced iron bean, iron pearl millet, zinc wheat, zinc rice provitamin A maize, cassava, orange, and sweet potato etc. The conventional breeding techniques are mostly used to produce bio-fortified crops than transgenic method because of their failure. The number of households approached for the introduction of iron bean in Rwanda, Uganda and Democratic Republic of Congo, iron pearl millet in India, zinc wheat in India and Pakistan, provitamin A maize in Zambia, provitamin A cassava in Nigeria and Democratic Republic of Congo,

provitamin A orange sweet potato in Uganda, zinc rice in Bangladesh have increased from 0.25 million to 1.8 million from the year 2012 to 2015 (Bouis and Saltzman, 2017).
In India, ICAR is working on behalf of government to produce bio-fortified varieties of different crops and their promotion. 31 such varieties are bio-fortified in iron, 28 in zinc and 17 in protein with maximum bio-fortified varieties developed in wheat (22) followed by maize (11), pearl millet (8) and rice (7) (Yadava et al., 2020). Hence, it becomes moral duty of various extension agencies public or private to aware the people about the balance diet for their good health.

Balanced Diet:-

A balanced diet means when all the required nutrients are provided in proper proportions in our diet. Li and Siddique (2020) stated two major gaps in our current agricultural and food systems i.e. production gap and nutrition gap. As the world population is increasing exponentially, the crop production has to increase more to feed even the poorest sections/marginalized section of the society. But our current staple food crops do not provide all the nutrients required for a balanced diet. A balance diet can be achieved by consuming all food crops namely cereals, millets, pulses, vegetables, fruits, milk & milk products, meat, egg, fish and oil/fats, nuts and oilseeds to get the required carbohydrates, proteins, fats, vitamins and minerals for a healthy mind and body. It is recommended to intake 0.8-1.0g protein/kg of body weight for a healthy adult according to the American Dietetic Association (ADA).
Therefore, a paradigm shifts from conventional agriculture and food system to diversified food consumption is needed to address the problem of global hunger. In this context, FAO (2018) while discussing the nutritional food security has defined Future Smart Foods (FSFs) as neglected and under-utilized species that are nutrient rich, economically viable, climate resilient and locally available with wider adaptability. Globally, only thirty thousand plant species have been identified as edible plant species out of more than five lakh species and more than seven thousand crop species of above identified species have been cultivated, domesticated or collected from forest as food throughout the human history (Garn and Leonard, 1989). Out of 150 commercially cultivated crops, 103 crop provides 90 percent of calories and wheat, rice and maize accounts for 60 percent of food energy intake (FAO, 1995). Therefore, the Neglected and Under-utilized Species (NUS) plays an important role to counter the problem of hunger as well as to reduce the over-reliance on a few crops.

Pulses form a major portion of FSFs and includes Dry beans, Field pea, Faba bean, Cowpea, Lupin, Common bean, Lentil, Mung bean, Chickpea, Pigeon pea, Black gram and others; grain legumes such as Soybean and Peanut used for oil extraction are excluded (FAO, 2016). The United Nations had also declared 2016 year as 'The International Year of Pulses'. Pulses contain protein (20-25%) twice of that present in wheat and three times more than in rice that could help in obesity (Singh and Yadav, 2020). Other than protein, lentil has highest vitamin A followed by chickpea, pigeon pea and horse gram. Rest of vitamins are present in minute quantity in pulses. India ranks first in terms of area (35%) and production (25%) in pulses, but the yield of pulses is low (885 kg/ha) compared to the world's average of 986 kg/ha and other countries whose yield of pulses is in thousands per hectare (Anonymous, 2022a) and nearly imports 25 percent of pulses to meet our national demand. Furthermore, the per capita availability of pulses (80g/capita/day) has drastically decreased from 60.7g/capita/day in 1951 to 52.9g/capita/day in the year 2017 which indicates 13 percent decline in per capita availability of pulses (Pawar and Adhale, 2022). This is because of this reason; pulses are considered as NUS and there is a need to increase the productivity of pulses as there is potential to achieve at least up to per capita availability of the 1951 year.

Millets are good source of energy and are gluten free. They are also low in sugar which makes them a better alternative for diabetic patients. Millets are rich source of vitamin B complex, iron, potassium, calcium, magnesium etc. The year 2023 is also being celebrated as 'International Year of Millets'. India contributes to 20 percent of global and 80 percent of Asia production. The Indian government had included millets in the union budget to make India as global hub of millets called **Shree Anna**. A variety of Shree Anna are grown in India such as Finger millet (Ragi), Pearl millet (Jowar), Sorghum (Bajra), Little millet, Ramdana, Cheena, Kodo millet etc.

Similarly, fruits & vegetables, roots & tubers, nut and spices are part of FSFs. Pumpkin is tolerant to heat and humidity whereas snake gourd is high salinity tolerant and rich source of dietary fibres, vitamins and minerals. Amla and citrus fruits are rich source of vitamin C while carrot and spinach a good source of vitamin A and iron respectively. Moringa tree having high nutritive value is another example whose every part can be used. There is also needed to make our agriculture sustainable.

Sustainable Agriculture:-

Rao and Rogers (2006) defined sustainable agriculture as a practice that satisfies current as well as long term needs for food, fiber, and other related needs of the society while maximizing net benefits through conservation of resources to maintain other ecosystem services, functions and long-term human development. According to FAO, sustainable agriculture refers to the management and conservation of resource base and the orientation of technological and institutional changes in such a manner that ensures attainment and continued satisfaction of human needs of present

and future generations (Acharya, 2012). As we have discussed earlier, the chemical agriculture nowadays will not completely help to achieve food security. But what is food security? FAO Summit (1996) stated that food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet out their dietary needs and food preferences for an active and healthy life (Sharma *et al.*, 2024). Therefore, a sustainable approach is needed as it covers all four food security concepts i.e. **Food availability (**adequate physical food availability at people's disposal on a consistent basis), **Food access (**People must be able to purchase adequate food regularly and have the purchasing power), **Food utilization (**proper biological use of food which covers a diet providing sufficient energy and essential nutrients, potable water, and adequate sanitation) and **Food stability (**Ensuring food supply at household level remains more or less constant, resilient to climatic shocks, war conflicts, price volatility, famine etc.)
Sustainable agriculture is a broader term in which major practices followed are soil conservation, water management, agroforestry, organic farming, agriculture diversification, resource management etc. including climate smart agriculture and conservation agriculture. The soil conservation is done by different methods followed in different regions such as mulching, crop rotation, nutrient management, no till farming, green manuring, addition of organic matter, contour farming, terracing etc. Mortan *et al*. (2023) in a study found positive association of soil zinc availability with child's linear height growth and that of soil iron availability with haemoglobin levels. Therefore, soil mineral availability (both macro and micronutrients) impacts the human nutritional status and health in some parts of India through agronomic fortification. As the condition of drought is now prevailing more and more, an important factor to supply irrigation water is through watershed management to do rainwater harvesting. Furthermore, the diversification in agriculture helps mitigating risks relating to farming such as rearing of livestock, apiculture, sericulture, poultry rearing, pisciculture, mushroom cultivation, hydroponics, aeroponics, floriculture etc. as per the farmer's capacity and the location helps in mitigating the failure of one component by the other component. Also, the health-related risks due to drastic use of synthetic chemicals is now well-known to the world. The food availability especially after covid-19 has created a demand of poison-free food which resulted in popularization of organic farming.

Role of Extension Agencies:-
All the initiatives taken by the government to achieve zero hunger will become zero if there are no extension agencies to help in implementing them. The role of extension agencies is much wider, but the major roles played by them are:-

- **Awareness-** Creating awareness is the foremost thing to do whether to the general public or the farmers. The awareness camps should be organised to aware public about a nutritious balanced diet, malnutrition and bio-fortified crops. The famers need to be aware about organic farming, sustainable agriculture practices, integrated nutrient and pest management, bio-fortified crops etc.
- **Pluralistic extension-** The government extension agencies alone can't do all the work as they have limited funds and human resources and lack of mobility of resources. Therefore, convergence of multiple sectors i.e**. public sector, private for-profit sector, private non-profit sector and producer organizations** cater to the information, advisory, delivery and support service needs of farmers. Sulaiman *et al*. (2012) had observed that pluralism had brought additional manpower and resources for extension and advisory services (EAS) along with new knowledge, skills, and expertise. For example, HarvestPlus working with CGIAR institutes and ICAR to develop bio-fortified crops and the delivery part is handled by different NGOs.
- **Dissemination of improved recent technology-**The extension agencies help in dissemination of recent technology which can benefit the farmers to improve their farming practices. For example, use of drone technology for crop & livestock monitoring, planting, chemical spray and market access, laser leveller, bio-fortified varieties etc.
- **Establishing linkage among actors in value chain-**Helping farmers to engage in value chain and add more value to their products whether changing their forms or appearance. For example, millets as such may not be much preferred by consumers. Therefore, they can convert raw millets into noodles, pasta, biscuits, multigrain flour etc. or they can be linked with such industry to do so. Farmer Producer Organization are needed to be promoted for the benefit to farmers especially marginal and small farmers.
- **Capacity building-**Extension agencies also help in capacity building because if the farmers do not know how to use the given technology, the dissemination of technology will be futile. It includes creation of skills, their use/development and repetition of the acquired skills so these may not be lost in the long run. Capacity building helps in changing Knowledge, Attitude, Skills and Ability (KASA). For example, for promoting organic farming knowledge need to be induced to change their attitude toward organic farming; and through training their skills and abilities are build-up so they can manufacture the plant and animal-based extracts/formulation in their home.

Food Security Status - A Case Study of Rural Bihar
To understand the role of extension agencies in policy implementation and how much condition of Bihar state has changed in regard to malnutrition, a case study of rural Bihar was analysed. It was reported that 89 percent of its

population resides in rural area and 52 percent are under multidimensional poverty (NITI Aayog, 2021). The state consists of 38 districts projecting 8.6 percent population of India. The overall literacy rate was observed 61.8 percent and in the rural Bihar, the same was found to be 59.78 percent according to 2011 census. The average population density in Bihar was 1106 persons per km^2 which was very high compared to national average of 382. The agriculture sector has great influence on its economy after the bifurcation of the state in 2000. The farmers grow a variety of crops such as cereals, oilseeds, fibre crops, sugarcane, fruits, vegetables, flowers and other crops. In case of mineral availability, major minerals are granite, bauxite, mica, limestone and quartzite and minor minerals of the state are sand, soil and stone. The state has been the major holder of pyrite resources (94%) in the country. In 2012-13, the net sown area was 57.7 percent and total forest area was of 6.6 percent. The cropping intensity was 144 percent. The maximum cropping area was under cereals (86.16%) followed by pulses (7.09%) and sugarcane (3.51%) (Anonymous, 2016).

Bihar is second last in performance towards SDG-2 (zero hunger) among states and UTs in the aspirant category where 43 percent of the children under the age of five are stunted and 23 percent of them are wasted (NFHS- 5, 2019–21). Sharma *et al.* (2024) in a study on three dimensions of food security i.e. food availability, food access and food utilization at district level by taking 15 indicators reported that the food availability depended not only on agriculture production but also on the growth of markets and transportation of food-grains from the surplus areas of production to the scarce areas. The food accessibility was linked to production and productivity of the agriculture sectors as well as on the employment opportunities. The districts where the industries were well established mainly because of mine industry had better access to the food. The districts namely Rohtas, Begusarai, Sheikhpura, Kaimur, Sheohar, Gopalganj, Aurangabad, and Siwan were found to be highly food secure in terms of the Food Utilization Index because of high female literacy rates and better sanitation facilities. The authors further reported a lower rate of diseases among children under five years age group in these districts. So, for as district-wise food security index of rural Bihar was concerned, Rohtas district was found to be **highly food secured** followed by Begusarai, Jehanabad, Sheikhpura, Gopalganj, Bhojpur, Aurangabad and Siwan districts while Kishanganj, Katihar, Darbhanga, Gaya, Purnia, Supaul, Araria and Jamui districts were in the **highly insecured category** in the food security index. The major factor that determined the food and nutrition security was availability of other labour than agricultural labour. Besides it, the non-dependency ratio, high female literacy rate, low percentage of diseases among children, extent of irrigation facilities, number of primary and civil health centres availability and percentage of non-SC & ST population were the other key determining factors. Most of the districts who were moderate to highly secure were those from where the Ganga River flows giving alluvial and the other types of fertile soil for agricultural production. Rohtas district was highly secure in food security index because of presence of a number of minerals and availability of non-agricultural labour to be employed in processing, mining and other industries. Similarly, district Begusarai's high food security was because of presence of manufacturing units as well as the River Ganga and the River Kosi flows through this district. However, the status of Bihar has improved over the years in NSFA implementation and now ranked at 11^{th} position in NSFA implementation in 2022 year (MoCAFPD, 2022). Hence, it has been concluded that there are numerous factors such as demography, agriculture, policy implementation, industrial growth, economy, awareness & literacy rate etc. which influence the food security status in any region. In spite of this, there could be certain limitations or obstacles as malnutrition is still a big issue to mitigate and achieve zero hunger within the time period in the framework of SDGs. The prominent problems in the implementation of programme are mentioned below:-

- **Urbanization-** According to a report of FAO (2023), urbanization and changing agri-food systems have created two food environments viz; **Food Deserts** (those areas where the residents' access to diverse, nutritious or fresh food is limited or even non-existent because of low density or absence of food entry points) and **Food Swamps** (areas where food is in overabundance with high energy density and low nutritional value).
- **Cultural and agricultural diversity** create a hindrance in uniform distribution of technology as each region has different problems and site-specific solutions.
- **Gender inequalities** is still prevalent in some parts of the country, particularly in case of women as they are not well educated about the sanitation, hygienic environment and dietary needs, though it has improved over the decades.
- **Lack of human resources and fund-** In India, the extension agents are less than the recommended ratio of 1:750, thus, creates a lack of human resources at the grass root levels. Furthermore, India spends only 0.7 percent of agriculture GDP on agriculture research and education which is less than that recommended (2%) by the World Bank (Nandi and Nedumaran, 2019).

Conclusion:-

It has been concluded from the paper that India requires a holistic and continuous approach to achieve zero hunger for which agriculture needs to be transformed into more diversified, nutritive-sensitive, economically viable and climate resilient system besides strengthening the food distribution system so that food security may reach in every corner of

the nation. Furthermore, the cultural and agro-ecological aspects should also not be undermined while framing and implementing policies pertaining to food security. Concerned efforts need to be made by extension agencies for promoting adoption of scientific agriculture practices by farming community which could be possible by organising regular trainings especially for women emphasizing on preservation of fruits & vegetables to reduce post-harvest losses.

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