Multifunctional Agriculture practices for India's Rural Development

Indian Constitutional Aid Assocation

Application of policies related to multifunctional agriculture in India's Primary Sector for Rural Development: Efficacy of Sustainable Agriculture Practices through Randomized Controlled Trials (RCTs) to increase disposable income of farmers in India

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ABSTRACT

Application of practices of multifunctional agriculture in rural development is a modern-day approach garnering adoption and investments throughout the world, especially in developing countries. India has been facing various socio-economic challenges and to address these challenges, the creation of human resources equipped with an optimum set of knowledge, skills, and policy ideation is imperative. These key components could engender technological sophistication and interdisciplinary thinking. Concerning India, practices in development policy hold a great significance as it enables the stakeholders to apply scientific, systematic and logical catalysts, and also to become future-ready. Development Policy needs to accommodate and explore knowledge base by various innovative ways and means. Rural development is also characterized by its emphasis on locally produced economic development strategies. In contrast to urban regions, which have many similarities, rural areas are highly distinctive from one another. For this reason, there are a large variety of rural development approaches used globally. Rural development actions mostly aim for the social and economic development of the rural areas. The term is not limited to the issues for developing countries.

Many of the developed countries have very active rural development programs. The main aim of the rural government policy is to develop undeveloped villages, agricultural practices, inter alia. Education contributing to rural development must be locally controlled, practical, applied, problem-posing, and focused on functional specialization. It diagnoses their needs, asserts their rights, and takes greater control of decisions affecting their lives, providing trained manpower in rural areas, linking rural and urban sectors, providing employment and income opportunities, increasing labor force productivity, and developing leadership. Rural development aims at finding ways to improve rural lives with the participation of the rural people themselves to meet the required need of the rural area.

INTRODUCTION

Advancements in technology concerning computing power, connectivity, artificial intelligence, biotechnology, and geographic information systems mapping[1], inter alia, can become one of the most prominent catalysts in rural development public policymaking in India. Scholars and policy practitioners identify the widening gap between skilled and unskilled labor as the extant issue with the positive outcomes of the industrial revolution[2], especially in primary sector development per se. The transition towards technological advancements should be careful considering the rate of unemployment being a directly proportional factor to automation in the economic industries.

As technology promises more substantial benefits in the primary sector with rapid advancements, the investment practices in this sector remain juxtaposed to the growth of the industry. The dearth of connectivity in rural areas along with equivocal computer knowledge and literacy act as impediments to development. Substantial investment is needed in physical infrastructure, power, broadband, transportation, and education, particularly in rural regions and among the poorest populations to truly reap the benefits of the 4th Industrial Revolution[3]. STEM education is pertinent in teaching practices that would help the rural population sustaining on agriculture and other farming activities to increase the substantial benefits while maintaining the balance between jobs that require manpower and those which can be replaced through automation.

The necessary changes have to be calculated based on a model devised out of comparative practices in countries that have the most developed primary sectors around the world and using Randomized Controlled Trials (RCTs) to assess the impact of those policies in the Indian context. An intricate study of these models can help bureaucrats develop a model that would make the gradual shift towards inculcating STEM practices in activities of primary sector workers and therefore, leading to the adoption of sustainable agricultural practices in the future. This paper aims to approach the hypothesis of the application of RCTs in the case of multifunctional agriculture and sustainable practices like agroforestry along with policy implications, agri-environmental policy in Nordic countries, and adoption of best practices for the Indian primary sector post-impact assessment, including technologies and experimental models used in developing countries to improve the productivity and sustainability of farmlands and other primary sector activities, inter alia.

MULTIFUNCTIONAL AGRICULTURE AND SUSTAINABLE PRACTICES

Multifunctional agriculture implies that it delivers a combined set of private and public outputs like food products, landscape values, and curb pollution. Multifunctionality refers to the fact that economic activity may have multiple outputs and, by this, may contribute to several societal objectives at once. Multifunctionality is thus an activity-oriented concept that refers to specific properties of the production process and its multiple outputs[4]. Multifunctionality implies that that private and public goods are complementary in nature, that is, if they're joint in output, their inputs cannot be assigned specifically to individual outputs[5]. There might be a situation where private and public goods compete over some common factor of production. Some types of biodiversity and water quality may have these characteristics in the sense that they compete with agricultural production or forestry[6].
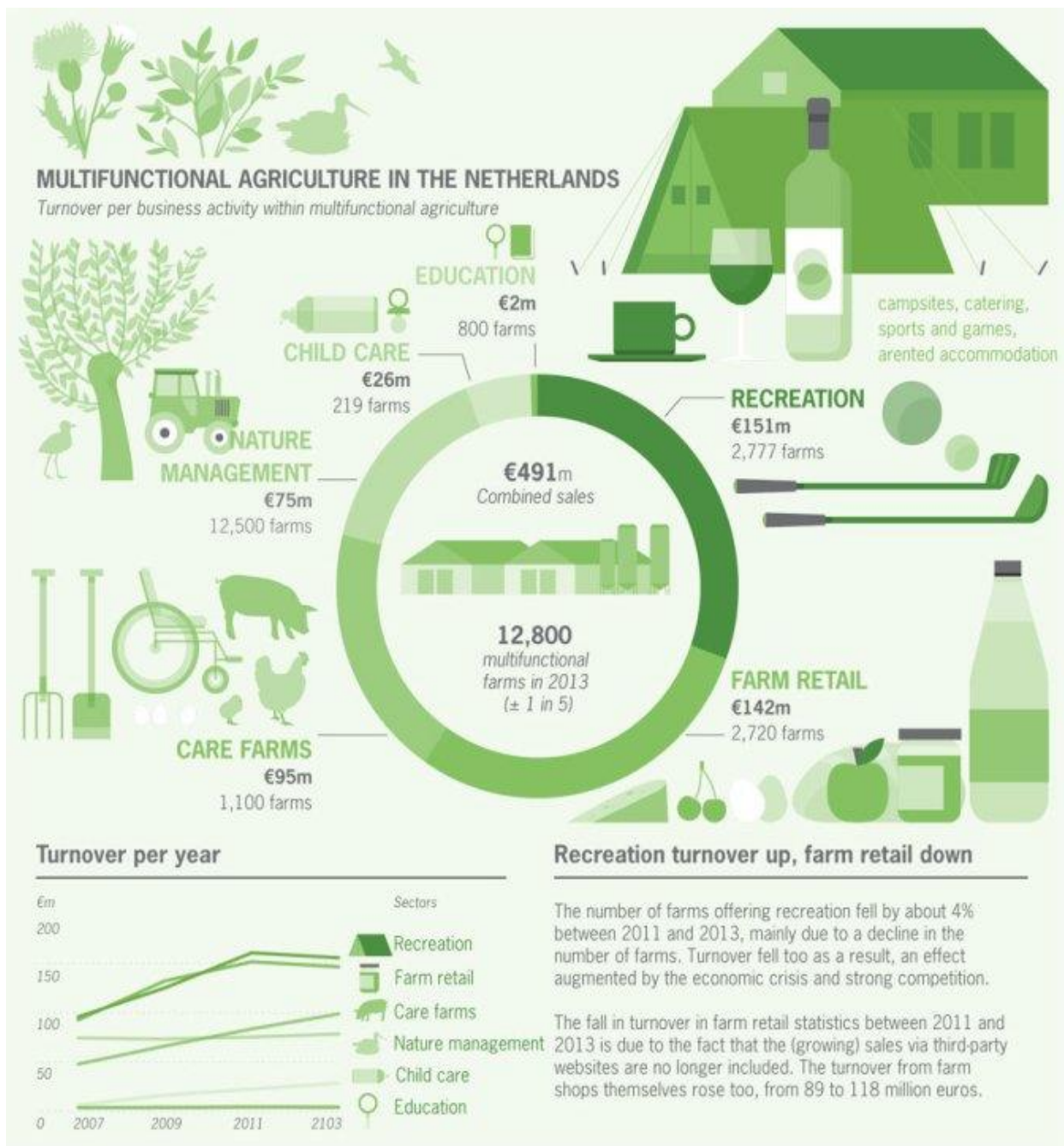
Multifunctional agriculture drives market forces to develop strategies concerned with accommodating the production and sale of both public and private goods to maintain the market equilibrium. To begin with, the application of cognitive practices like hypothesizing and making predictions about market response and buyer's behavior[7] towards produce from multifunctional agriculture can help the stakeholders of the farm production maximize their income. For such practices, mathematical models are engineered through expert consultative committees keeping in mind the empirical analysis of such hypothesis through trial runs and its application in a specific case, here, multifunctional agriculture.

They key to services under provided under multifunctional agriculture is the relationship between farms and civilians/consumers[8]. It can provide a range of services to consumers like farm education, farm shops, short chains, agriculture day care and nature management[9], and agricultural supply chain intermediaries, inter alia. Figure 1 presents the turnover per business activity within multifunctional agriculture in Netherlands to make a case for the utility of the practice in increasing the disposable income of farmers.

The figure explicitly points out that the success of activities under the domain of multifunctional agriculture are directly proportional to the availability of farmlands[10]. Low availability of farmlands plummeted the turnover propelled by strong competition and economic crisis[11]. Therefore, application of this practice needs to be in a context where external factors of inflation and market competition need to be factored at all times.

As per Figure 1, the most profitable activities in multifunctional agriculture have been care farms, nature management, farm retail and recreational activities. The highest margin of profit was generated by farms inculcating recreational activities with €151m from 2,777 farmlands which roughly generates an estimate amount of €54,375 per farm/year in turnover excluding proceeds from farm produce. The additional income is an exponential rise in the personal income of the farmer, after paying current taxes for that year's income, which ultimately leads to rise in disposable income of the farmers till the activities are generating added revenue. Therefore, multifunctional agriculture has proved out to be profitable for farmers in conditions of economic crisis and fierce competition.

Figure 1:

MULTIFUNCTIONAL AGRICULTURE IN THE NETHERLANDS
Turnover per business activity within multifunctional agriculture

EDUCATION
€2m
800 farms

CHILD CARE
€26m
219 farms

NATURE MANAGEMENT
€75m
12,500 farms

CARE FARMS
€95m
1,100 farms

€491m
Combined sales

12,800
multifunctional
farms in 2013
(± 1 in 5)

campsites, catering,
sports and games,
arented accommodation

RECREATION
€151m
2,777 farms

FARM RETAIL
€142m
2,720 farms

Turnover per year

€m
200
150
100
50
0
2007   2009   2011   2103

Sectors
Recreation
Farm retail
Care farms
Nature management
Child care
Education

Recreation turnover up, farm retail down

The number of farms offering recreation fell by about 4% between 2011 and 2013, mainly due to a decline in the number of farms. Turnover fell too as a result, an effect augmented by the economic crisis and strong competition.

The fall in turnover in farm retail statistics between 2011 and 2013 is due to the fact that the (growing) sales via third-party websites are no longer included. The turnover from farm shops themselves rose too, from 89 to 118 million euros.

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The table below explains various indicators in different types of economies to contextualize India's case. Based on the table below, a thorough analysis can be drawn on whether sustainable approaches through multifunctional agricultural practices and tools can be adopted into India's primary sector for rural development and argue about the conjectured policy implications of such a transitional shift from a factor-driven economy to an innovation-driven economy.

Table 1:

Indicators	Stages of Economic Force		
	Types of Economies		
	Factor-Driven Economy	Efficiency-Driven Economy	Innovation-Driven Economy
Economic Basis	Factor Endowments (primarily unskilled labor, natural resources)	Efficient Production process and improved product quality	Innovation products/services, focus on high added value tasks
Aim	Primary Production and Extraction	Value-added and Manufacturing	R&D and new product or service delivery
Growth Via	Increased Inputs	Increased output per unit of input	Increased output due to new markets
Key Projected Success Factors	Low wages, well functioning public-private institutions, developing infrastructure, stable macreconomic development, and healthy workforce	Education and training, basic technological skills, efficient goods, growth of labor and financial markets, and large domestic or foreign markets	Most developed and optimum production process, globally oriented business process, and capability to innovate existing practices

The practices followed in India's primary sector make it inevitable to be characterized as a factor-driven economy that needs to make a transitional shift gradually through the adoption of certain best practices as seen in the case of Netherlands. Rural development policy requires intensive investment practices in the agricultural sector to develop technologies and make the population adept with the conditions in which they can be used for overall alignment with the globally-oriented business practices and the ability to become self-sufficient in innovating obsolete practices that are obdurate. In 2019, the agriculture sector's share declined to 14%[14] while more than 50% population still depends on agriculture for income[15]. At present, India witnesses a run of unsustainable farming practices that have led to rapid depletion of the groundwater table, soil nutrient levels, and air pollution[16] as a result of hackneyed practices both in terms of agriculture and rural development policy.

Indian agriculture depends on patterns of mono-cropping, water-intensive cropping choices, and chemical-laden cultivation[17]. These practices rely on Green Revolution when the government pervasively supported cropping practices that gave massive output on minimum input. The need back then was to make India self-sufficient in food crops, thus wheat and paddy were the crops that were most preferred by the government. Contemporarily, India has an excessive stock of paddy and wheat due to the farmers largely sticking to cultivating paddy and wheat due to assured procurement by the government[18].

Due to obsolete farming practices, farmers in India run on a debt economy and get low returns on their investments and are, therefore, pushed into measures that yield no benefit to sustainable practices or their investments. As India's primary sector needs to make a gradual shift from a factor-driven economy to an efficiency-driven economy, it is imperative that investments into value-added production, education and training, and basic technical skills are made. Restructured government support and rigorous evidence generation through

data acquisition and analytics[19] can help reduce the burden of continuing existing agricultural practices and move towards sustainable agricultural practices. Sustainable agricultural practices will factor in the most developed and optimum production process along with perennial growth through advancing innovations. Sustainable agriculture offers a much-needed alternative to conventional input-intensive agriculture, the long-term impacts of which include degrading topsoil, declining groundwater levels, and reduced biodiversity[20]. It is vital to ensure India's nutrition security in a climate-constrained world.

Institutional context is a major factor in farm behavior and the intrinsic motivations of farmers[21]. Intrinsic motivations are imperative for determining how farmers respond to environmental policy instruments and could either complement or constrain the effect of policies as their application comes into effect. These claims are based on the pieces of evidence collected from studies and surveys conducted amongst the Nordic agricultural community of farmers and stakeholders in the primary sector[22]. The evidence is germane in understanding the impact of policy through experimental analysis such as multifunctional agriculture and reaction towards joint public and private goods along with the implications of environmental policies on the same.

AGRI-ENVIRONMENTAL POLICY AND RANDOMIZED EVALUATIONS

To make a gradual transition, government policy concerning rural development should focus more on R&D and new product or service delivery to enhance the growth via increased output due to new markets[23]. The emphasis on agri-environmental policy is imperative to initiate sustainable agriculture practices increase the utilization of factor endowments to focus on product improvement[24] and high value-added tasks[25]. A similar transition was made through the Danish Rural Development Program that focused on enhancing the rich nature of the soil and clean environment with several impact indicators including water and greenhouse gas emissions. The purpose of studying Denmark's case is to look into the best practices of agri-environmental policy implemented in the region and analyzing the impact of the application of these policies in India's primary sector activities for a holistic Rural Development policy to be constructed.

The Danish Rural Development Programme (2014-2020) focused on the improvement of groundwater quality through a reduction in nitrogen surplus[26], incorporating more renewable energy projects in rural areas to combat climate change and accentuate energy efficiency[27], and reduction in phosphorous emissions[28]. The importance of these strategies has been highlighted in scientific studies concerning India[29] as well and a model is required to be devised to understand the potential impact of these strategies if and when they're applied in the primary sector of India. Nordic experiences in the application of agri-environmental policies for rural development can help India in devising strategies to make multifunctional and sustainable agricultural practices pervasive in the current ecosystem. To adopt certain best practices from Nordic experiences in rural development and poverty alleviation, and evaluate their outcomes in the Indian context, Randomized Controlled Trials (RCTs)[30] are essential to be incorporated in policy research and evaluation.

Randomized evaluation is an impact evaluation method. Candidates of the study are randomly assigned to one or more groups that receive (different types of) an intervention, known as the "treatment group" or groups, and a comparison group that does not receive any intervention[31]. Researchers then measure the outcomes of interest in the treatment and comparison groups. Randomized evaluations augment in obtaining a disinterested estimate of the causal impact of an intervention, that is, what specific changes to participants' lives can be attributed to the program[32]. They also allow researchers and policymakers to tailor their research designs to answer specific questions about the effectiveness of a program and its underlying theory of change.

The application of RCTs in multifunctional agricultural experiments can yield results to determine whether sustainable agricultural practices like Agroforestry[33] can help in containing the impact of climate change and improve the livelihoods of the impoverished farmers. The significance behind agroforestry is imperative for understanding the extent of land-use options that improve livelihood security[34] and reduce vulnerability to climate change[35]. In this case, RCTs can be used by dividing organic farming areas into treatment groups and comparison groups to study the impact of the multifunctional agricultural activities like recreation, nature management or farm retail and its pervasive use in the regions targeted to regions that weren't subject to any intervention.

Organic farming areas in Northern India include Himachal Pradesh, Chandigarh, Uttarakhand, and parts of Jammu and Kashmir[36]. These regions can be put under randomized controlled trials groups to evaluate the response towards multifunctional agroforestry and based on this study, a comprehensive rural development policy can be constructed for the rest of India as well. The impact assessment through RCTs would largely focus on the marginal propensity of livelihood security, regulating climate change, and enhancing soil fertility and water efficiency to increase the yield of the farmland to meet the demand of the market and controlling prices as per the supply of the harvest.

Disposable Income Intervention

Hypothesis:

Let the Set N represent farmers in India working on organic farmlands

Let I represent Personal Income of Farmers through sale of produce from farmlands

Let T represent Personal Current Taxes paid by farmers

Disposable Income (DPI) = Personal Income – Personal Current Taxes

$$\forall\ I, T \in N \quad DPI = I_x - T_x$$

Where, x denotes current year, other factors remaining constant.

Policy Intervention Hypothesis

Intervention from adoption of multifunctional agriculture and subsequent proceeds from sale of produce in domestic markets: -

→ Let proceeds from sale of produce from multifunctional agriculture be denoted by y, where $y \in R: (-\infty, \infty)$

CASE I:

If proceeds from sale of produce from farmland after adoption of sustainable agricultural practices (multifunctional agriculture) leads to more revenue generation,

$$DPI_x = (I_x + y) - T_x$$
$$where\ y \in R: [1, \infty)$$

CASE II:

If proceeds from sale of produce from farmland after adoption of sustainable agricultural practices (multifunctional agriculture) leads to stagnant revenue generation,

$$DPI_x = (I_x \pm y) - T_x$$
$$where\ y \in R: (-\infty, 0] \cup [1, \infty)$$

CASE III:

If proceeds from sale of produce from farmland after adoption of sustainable agricultural practices (multifunctional agriculture) leads to negative revenue generation due to increased cost of liabilities,

$$DPI_x = (I_x - y) - T_x$$
$$where\ y \in R: (-\infty, -1] \cup [-1, 0]$$

Trees in agroecosystems can ameliorate soil productivity through biological nitrogen fixation, efficient nutrient cycling, and deep capture of nutrients and water from soils[37]. Even the trees that do not fix nitrogen can enhance the physical, chemical, and biological properties of soils by adding a significant amount of above and belowground organic matter as well as releasing and recycling nutrients in tree-bearing farmlands[38]. Ecological intensification of cropping systems in fluctuating environments[39] often depends on reducing the reliance on subsistence cereal production[40], integration with livestock enterprises, greater crop diversification, and agroforestry systems that provide higher economic value and also foster soil conservation[41]. Maintenance and enhancement of soil fertility are vital for global food security and environmental sustainability[42].

Technology transfers to enable multifunctional agriculture[43], agroforestry per se, have to be made by rural development authorities to incentivize farmers to make a gradual shift towards sustainable agricultural practices while preserving some of their traditional practices[44]. With the application of RCTs in evaluating the impact of this policy, the future impact of multifunctionality can be projected and diligently applied across the state. Impact evaluation through these trials could reveal the potential of agroforestry systems having a multifunctional value in India and other developing countries with similar farming practices and share of primary sector in the GDP[45].

Decentralized planning and implementation of strategies that promote local biomass production[46] in agroforestry systems can aid in understanding how livelihoods of impoverished farmers residing in rural and underdeveloped areas can be improved along with transitioning to sustainable development[47]. In addition to mitigating climate change, agroforestry systems can partially meet the energy needs of a few billion people in India[48] through bioenergy options by prudent use of agricultural residues and biomass generated in agroforestry systems[49]. Biomass energy-based supply options can create rural wealth and employment necessary for livelihoods improvement[50] and sequester a large amount of carbon in a decentralized manner[51]. Such a strategy would also ensure ecological, economic, and social well-being[52].

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