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Review Article

Intensification of Food Production Systems: A Boon or a Bane?

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Abstract

Food production systems are intensified because of various acts taken by people on an individual, community, or organisational level. The need for intensification in the form of greater output is most pressing when the food supply needs to be increased, such as during periods of high population growth. When social or environmental problems are involved, intensification that uses resources more effectively may be more important. In either case, changes brought about by intensification should be cognitively understood as opposed to extensive modifications, which involve either a rise or fall in the number of inputs utilised. The necessity of sustainable intensification of food production systems is emphasised in this assessment, along with its benefits and drawbacks.

Keywords: Crop; Food Security; Intensification; Livestock; Production Systems

Introduction

An increase in agricultural output per unit of input is referred to as agricultural intensification (which may be labor, land, time, fertilizer, seed, feed, or cash). Practically speaking, intensification happens when the total volume of agricultural production increases due to higher input productivity or when agricultural production is maintained while some inputs are reduced (such as by more effective delivery of smaller amounts of fertilizer, better targeting of plant or animal protection, and mixed or relay cropping on smaller fields). Historically, increasing or decreasing the area of land planted has been the most frequent and productive extensive change in agricultural productivity [2]. Instead of referring to ideas that can be applied to an economic or technical study of circumstances, the contrast between intensification and comprehensive adjustment is meant to show the contrast between two broad techniques that humans have had for changing their food supply. The technological requirements and methods for measuring intensification or substantial correction in every scenario are very intricate [13]. Adjustments to the number of numbers are likely to follow changes in the productivity of one input. Despite its complexity, agricultural intensification has unquestionably been a prerequisite for human civilisation [2]. The technological revolution has been based on the organised gathering, concentration, selection, and harvesting of plant and animal species to have more items available and simpler to transform into food. The domestication of farm animals and the creation of crops, in the setting of ever-more productive agricultural systems, allowed the human population to increase and towns and villages to flourish, with governments, laws, trade, and economies with specialised employment [3].

Population growth followed a rise in agricultural productivity. There has been debate among historians on whether higher populations enabled or facilitated technical advancement. But during this progress, most societies suffered from chronic undernourishment or were victims of sporadic famine. Most communities relied on local manufacturing because of relatively high transit costs, except for when water transport made imports feasible. Over 95% of civilization's history, food has been scarce for most people, which has led to poor life expectancy, illness susceptibility, and lack of resistance to wars, droughts, floods, and other man-made and natural disasters [5]. Food shortages and social unrest led to large-scale human migrations, wars, and profound cultural change. Understanding the ethical concerns associated with intensification can be approached from both a prospective and a retrospec-

tive perspective, and ethical standards for assessing intensification can be approached from either a broad perspective on the overall trend of events or from a more focused perspective on the roles of key actors. The present review primarily examines the benefits and drawbacks of intensifying food production systems [6].

Need for intensification of food production systems

Sustainable intensification is a goal, but it doesn't state how it can be achieved in advance, such as which agricultural methods to use [7]. It can be paired with a few other enhanced management techniques, such as agroforestry or conservation agriculture, which has further advantages for the economy, ecosystem services, and carbon sequestration. Sustainable intensification minimises emissions and helps to address yield gaps by increasing the use of nutrients, water, and other inputs efficiently [7]. It also helps to prevent the loss of these production resources [16,18]. The utilisation of land per unit of output can be made more effective by closing yield gaps. Less than 40% of the potential crop production has yet been reached in the majority of Africa and South Asia regions [12]. The production of more products per unit of land using integrated agricultural methods (such as mixed crop/livestock, crop/aquaculture) is particularly relevant in terms of food security. By 2050, there will be an urgent need to produce nearly 50% more food to feed the growing global population [6] but doing so could result in major increases in Green House Gas (GHG) emissions and other environmental effects, including a loss of biodiversity.

Sustainable intensification recognises that increased productivity requires the maintenance of other ecosystem services and increased shock resistance [17]. To increase sustainability in the broadest sense, sustainable intensification in intensively farmed areas may need an output drop [2]. Therefore, achieving sustainability may need to yield growth rates that are less than those that are ultimately possible under such circumstances. Intensification of agriculture is one of the cornerstones of the plan to protect forests in areas that have rich natural ecosystems, such as the primary forest in the Congo basin [17]. One strategy to achieve the goals of food security, climate change adaptation, and mitigation is to intensify agriculture [16]. Recent proposals for Sustainable I-intensification (SI) are based on the idea that the advantages of producing more food on new lands balance the harm that extensification causes to the environment [8]. However, expanding the net production area by recovering existing degraded land may contribute to greater output on the one hand and increased carbon sequestration on the other [9], so enhancing natural capital outcomes and agricultural productivity [14].

Sustainable intensification doesn't always provide co-benefits in terms of food security and coping with or mitigating climate change, though. For instance, in the case of Vietnam, increased production of rice and pigs reduced GHG emissions in the near-term using land-sparing techniques, but after 20 years, the emissions linked to higher inputs were projected to outweigh the savings from the use of land-sparing techniques [1]. All parts of the food system must be intensified sustainably, which requires reducing agricultural sprawl, regenerating soils, repairing damaged areas, lowering agricultural pollution, improving water usage efficiency, and using fewer external inputs [5]. According to research by Palm., *et al.* 2010, in Sub-Saharan Africa, intensification scenarios can meet goals for food security and climate mitigation at low population density and high land availability, leaving extra cropland available for reforestation. In contrast, achieving food security and lowering GHG emissions necessitates using more mineral fertilisers to make land available for reforestation in areas with high population density and small farm sizes. However, due to unfavourable consequences including environmental degradation and greater social inequality, some types of intensification in dry lands may enhance vulnerability rather than decrease it [15].

Sustainable intensification has come under fire for primarily looking at the supply side of food security when ensuring global food security necessitates paying attention to all facets of the food system, such as access, usage, and stability [8]. Additionally, the adoption of high-input agricultural practices under the pretense of enhancing yields and environmental performance will draw more investment, resulting in a larger adoption rate, but the environmental component of Sustainable Intensification will be abandoned fast [8]. When adopted, s-sustainable intensification must work with the sustainable development agenda to identify sustainable intensification agricultural practices that support rural communities, viz to enhance the livelihoods and employment of smallholders, and mitigate adverse social and cultural effects like forced migration and loss of land tenure; invest in the social, financial, natural, and physical capital needed to facilitate sustainable intensification implementation; and developing mechanisms to compensate underprivileged farmers for engaging in sustainable intensification [7].

Sustainable intensification: implications for livestock

Although intensification in the livestock industry could increase food production for expanding populations, there are moral concerns about the use of livestock resources, the safety, and quality of the food produced, equity, and animal welfare. In both industrialized and developing nations, intense livestock production and processing have resulted in widespread pollution of the land, water, and air, which frequently serves as a path for the spread of illness. In addition, there are immediate problems with disease transmission and general food safety [11]. Additionally, excessive intake of animal products poses various dangers to human health. While it would be ideal for developing nations to consume more animal products to fight malnutrition, it may not be a good idea for these countries to adopt the dietary habits of developed nations. The use of grain by livestock, which accounts for around one-third of global grain production, places a strain on the land and other natural resources and requires the use of fossil fuels. You could argue that animals should be fed this grain rather than humans. These environmental and food safety risks serve as a list of potential expenses that must be compared against the advantages of intensifying livestock production [9].

The distribution of benefits raises further ethical questions. Although an increase in the market for animal products appears to present prospects for the rural poor, most of these people have not yet been able to seize these opportunities [3]. The fairness of initiatives to increase livestock output and the effects that such efforts have on traditional rural communities are therefore significant ethical questions. There are several difficulties related to cattle industry intensification that affect the animals themselves. If left unchecked, the intensification of livestock output is linked to methods of animal management that prevent the expression of instinctive behaviour [4].

The sustainable production of food, bio-based goods, and bioenergy, including biofuels, is possible thanks to many good practices. These strategies include agroecological zoning and intensifying sustainable agriculture to produce bioenergy in addition to food. Additionally, increasing the use of biomass for energy and creating integrated food-energy systems that maximise land use, such as mixed food-energy crop systems, are both very promising (e.g., biogas from livestock manure) [2]. Through the intensification of livestock systems, this expansion and the rise in demand for meat and dairy products were reconciled [10]. The growing need for animal protein has been a significant aspect of global dietary change. Worldwide, the number of chickens has expanded fourfold, the number of pigs has increased twofold, and the number of cattle, sheep, and goats has increased by 40–50% [13]. Since 1970, meat and dairy consumption in emerging nations has increased by 51% and 36%, respectively [1].

In addition to being able to feed the world in the area now used for agriculture, changing diets and reducing food system waste may also make it possible to lower input costs and mitigate the harm that present food production does to the environment. Additionally, there would be huge health advantages from increasing the proportion of plants in the human diet. In affluent nations, a large portion of agriculture is only profitable with government assistance [12]. The desire of society to preserve rural communities and rural economy in high-wage nations, particularly in regions where agriculture is not very productive, justifies such market-distorting intervention; nevertheless, significant political pressure from influential groups is also particularly crucial. But because the phrase "intensification" is frequently connected to farming methods, some people may respond negatively to requests for sustainable intensification [8]. When it comes to cattle production, where intensification is practically synonymous with factory farming, this problem is particularly apparent. While acknowledging this issue, we will continue to use the commonly used term sustainable intensification in the neutral sense of raising yields while lowering environmental harm for the time being. The term "intensification" is often used to refer to a certain type of livestock production where animals are kept in highly artificial conditions and fed high-input diets that are very different from their natural diets [3,4]. The breeds of animals employed are frequently heavily selected for specific yield goals, which can result in congenital health issues. Many people, especially those who practice animal ethics, believe that intensification shows little regard for the well-being of animals [2].

Many nomadic and semi-nomadic pastoralists depend primarily on livestock for their subsistence and have highly advanced ways of preserving harvests in frequently quite unfavourable circumstances. Investment in the health and well-being of cattle and other livestock is a priority because they often make up most of the person's wealth, even if these factors are frequently hampered by the lack of feed and endemic diseases [8]. As a result, welfare

as measured by physical health may be bad while welfare as measured by other factors, such as the freedom to engage in natural behaviours in a natural setting, may be positive. It is expected that some "intensification" of efforts to improve pasture quality and provide greater access to veterinary care will concurrently increase productivity and health, improving welfare overall [13]. In many cases, poor welfare results from a mismatch between the breed and its environments, such as when highly productive breeds are fed with subpar feed or traditional breeds are grown on commercially designed feeds, which have detrimental effects on health. Lack of knowledge, inadequate shelter, limitations on natural behaviour, or in rare situations, a disregard for good welfare, can all lead to low animal welfare [4]. In these situations, there is frequently a lot of room for improvement in terms of breed-feed compatibility, veterinarian treatment, and stockmanship. These enhancements can also increase productivity and produce better environmental results. In this case, the sustainable intensification and animal welfare agendas may be compatible, at least unless the intensification levels are high [8].

In many wealthy nations, yields are much greater and there is less possibility for development. According to recent studies, if animal health and well-being are given more consideration, large output increases are still feasible. Modern methods of monitoring behaviour and welfare, as well as advancements in our understanding of animal physiology and behaviour, can all be used to create husbandry practices that boost economic yields. It is also possible to re-evaluate animal breeding techniques, selecting not only for yield-related criteria but also to eliminate features that harm an animal's health or quality of life [4]. It may also be possible to use positive selection to favour features that increase welfare. However, there is a chance that further productivity gains in these highly intensive systems would not only be marginal but may also result in a decline in welfare. In these conditions, society must carefully assess its values and needs, especially its need for animal products. It might not be viable to maintain today's high-meat and high-dairy diets while still achieving high welfare and positive environmental outcomes; something might have to give [12].

The emphasis sustainable intensification places on decreasing environmental impacts and boosting resource efficiency might be applied locally to research on crops and livestock that are specially adapted to local conditions, thereby enhancing crop diversity and, consequently, nutritional diversity. The development of community gardens and methods that combine the production of terrestrial and aquatic foods fit with the sustainable intensification's emphasis on making efficient use of all available land resources on a nutritional level [7]. In other words, applying sustainable intensification thinking has the potential to enhance nutritional results. Sustainable intensification has yet to significantly improve the lives of individuals who are malnourished, and there hasn't been much acknowledgment of the necessity to link these two agendas. Sharp gains in food production from agricultural systems were made possible by new crop varieties, livestock breeds, increased use of inorganic fertilisers, herbicides, and equipment, as well as better water management. Over this time, the yield of many staple crops and livestock has changed [12].

Intensification of food production systems: highlights and challenges

Efficiency is crucial in utilitarianism, the most popular version of consequentialism. According to utilitarian theory, the values connected to consequences can be quantified to create a ranking system for all feasible actions (or alternatives) an agent could choose. They also believe that advantages and harms can both be added to and taken from [6]. No choice in the opportunity set yields a class of optima produced by such a ranking system that has a higher total value (although there may be more than one optimal option). The correct, best, and proper conduct or policy must belong to this class of optima, according to the utilitarian criterion (for example, the utilitarian maxim). Acting to achieve the greatest good for the largest number of people is how this is commonly phrased. Therefore, the path of action that is most thoroughly justified by ethics is the most effective way of generating benefits or avoiding harm [13].

The simplest and most obvious way to assess a complete food and fibre production system is through consequentialist ethical perspectives. The consequentialist believes that morality, goodness, and propriety should be judged according to how an action or policy affects one's health, prosperity, and well-being. The goal of intensification in the hypothetical situation is to increase the total amount of food available while using fewer inputs. Food production can be viewed as having a positive influence because it is essential to human life and health, especially considering the historically persistent food shortages. As previously mentioned,

intensification occurs during times of the rising human population [12]. Food shortage results in hunger, ill health, and starvation if the food supply does not increase in proportion. Numerous people and organisations consider possibilities and take actions that result in an expanded food supply using the framework already presented. The fundamental justification for intensification is the advantages of increasing food availability, and this justification is consequentialist in its moral reasoning. Consequence-based reasoning demonstrates why it is morally preferable when new farming techniques or technology enable a landowner to increase food production [13].

As previously said, utilitarian evaluation is famously oblivious to how benefits and evils are distributed throughout society [4]. Considering the prevalent belief that increases in efficiency and general welfare can occur in a very unjust manner, the topic of how burdens and benefits are allocated is thus highlighted. Simply stating that we are requesting that the methods and processes be assessed considering their consistency with a concern for human freedom (for example, an appeal to human rights), or regarding their impact on traditions and community integrity, is one way to respond to the claim that intensification is unfair (e.g., an appeal to virtues) [5]. Therefore, one could say that utilitarian thinking gives us a framework for arguing that intensification is a desirable thing, other things being equal, whereas rights and virtue approaches make us aware of the additional difficulties that must be addressed for intensification to be fully justified.

The necessity of a thorough accounting of costs and benefits is an important but frequently disregarded component of the utilitarian approach. New seed varieties that were more receptive to nitrogen fertilisers, which are often paid inputs, were part of the green revolution. Therefore, a straightforward utilitarian strategy balances the advantages of higher yields against the expenses of seeds and fertiliser [9]. The green revolution is appropriate if the advantages outweigh the disadvantages. Many criticisms of the green revolution can be expressed wholly within the context of a utilitarian/consequentialist ethic, while other changes came along with contemporary technology. Large-scale insect pest outbreaks and plant disease epidemics disrupted food production, supply, and pricing during the first decade of the 1970s green revolution, which increased overall rice production across Asia [6].

Conclusion

Population expansion serves as the foundation for a utilitarian case for intensification, and traditional leadership virtues may offer a code of conduct for pursuing intensification for the benefit of society. It is crucial to express the moral justification for intensification programmes in a way that draws from all the traditions that are available for defining and assessing an ethical obligation. To provide the increased demand for food and agricultural goods caused by an increasing global population, agriculture will need to be further intensified. However, intensification runs the risk of destroying natural resources and reducing food security if it is not properly managed. Additionally, it may have significant social repercussions, particularly regarding rural livelihoods. Planners must therefore identify and assess alternative solutions to achieve sustainable agricultural intensification, considering both their short- and long-term effects as well as their implications for all relevant socioeconomic groups. Therefore, the creation of such policies and the ensuing imperative for intensification has a strong ethical component.

Conflict of Interest

The authors declare that there is no Conflict of Interest regarding the publication of this article.

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NA.

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