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Research article

Crop Diversification, Agricultural Transition and Farm Income Growth: Evidence from Eastern India

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Abstract. This paper examines the role of crop diversification in agricultural transition towards high-value crops as well as farm income growth in Odisha, Eastern India. The empirical analysis reveals some crucial facts: first, a stagnant and relatively low level of crop diversification in Odisha agriculture. Second, there is an insignificant agricultural transition due to the negative *area substitution effect* for most of the crops, along with a *weak expansion effect* over the last two decades from 1995-2018. Third, a declining contribution of productivity growth coupled with an insignificant contribution of crop diversification to the farm income growth over the years. Hence, we conclude no or an insignificant agricultural transition from traditional to high-value modern agriculture in Eastern India, causing unsustainable farm income growth. This calls for an urgent need to promote a mixed cropping pattern and colossal investment to encourage the farmers to transition towards high-value crops, stimulating farm income growth. Furthermore, massive efforts are required to make farmers aware of the advantages of diversification.

Keywords: crop diversification, farm income, agricultural transition, Odisha.
JEL codes: C10, Q17, Q18.

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HIGHLIGHTS

- There is stagnant or little crop diversification in Odisha agriculture, causing insignificant transition to modern commercial agriculture.
- The low level of diversification is on account of the negative area substitution effect for most crops, along with weak expansion effect over the last two decades.
- The contribution of diversification is insignificant while the yield effect is almost nil in farm income growth.
- It is only price effect that sustains the slight growth in farm income.

1. INTRODUCTION

In smallholder-dominated agrarian economies, diversification of the cropping system performs multiple functions. It reduces farmers' exposure to downside risks (Birthal, Hazrana, 2019; Paut, Sabatier, Tchamitchian, 2019), conserves natural resources, regulates climate change, and provides ecosystem services (Bertoni *et al*., 2018; Matthews, 2020; Tamburini *et al*., 2020; Bertoni *et al*., 2021), and generates additional income and employment (Joshi *et al*., 2007; Basantaray, Nancharaiah, 2017). On the whole, crop diversification contributes to the sustainability of agricultural production systems and growth (Birthal *et al*., 2006; Nayak, Kumar, 2019; Akber, 2022), food and nutrition security (Pandey, Sharma, 1996; Satyasai, Viswanathan, 1996).

The literature on economic development indicates that the structural transformation of an economy is preceded by the diversification-led productivity growth in agriculture (Gollin, Parente, Rogerson, 2002; Emran, Shilpi, 2012; Bustos, Caprettini, Ponticelli, 2016). As the economy grows, the demand for high-value commodities[1] increases, which encourages farmers to diversify their production portfolios towards crops that generate higher returns with better market prospects and potential for value addition through processing and storage (Timmer, 2009; Sharma, 2005; Reardon, Timmer, 2007; Anwer, Sahoo, Mohapatra, 2019). Timmer (2009) argues that a sequence of progressively broader diversification steps defines a successful agricultural transformation as part of the broader structural transformation of the economy. Further, to deal with persistent agrarian distress, we require strategic intervention to reinvigorate the growth of farmers' income and farm sector growth at the aggregate level. Hence, diversification of the farm sector towards high-value crops (HVCs), including fruits, vegetables, spices, oilseeds and condiments, has proved quite effective in augmenting farm income and reducing rural poverty (Birthal, Roy, Negi, 2015; Michler, Josephson 2017). Moreover, HVCs are highly remunerative compared to the widely grown staple crops (Birthal *et al*., 2020).

There is sufficient evidence that agricultural growth has a larger impact on poverty reduction than similar growth in the non-farm sector (Christiaensen *et al*., 2011; Dutt, Ravallion, Murgai, 2020). This paper aims at understanding the sources of agricultural growth in Odisha, one of the poorest states in India, and explores whether crop diversification could be a pathway for agricultural transition to a higher growth trajectory. Agriculture in Odisha is dominated by smallholders and is under excessive employment pressure. It contributes about 22 percent to the state's gross domestic product and engages 62 percent of the workforce. The farm sector is plagued by low labour productivity, sluggish growth and high instability, rendering agriculture-based livelihoods unsustainable (Paltasingh, Goyari, 2013; Senapati, Goyari, 2019). Notably, landholdings in the state are small — approximately three-fourths of the total 4.87 million landholdings are of a size less than or equal to one hectare (OAS, 2018-2019). Again, over 41 percent of the rural population lives in poverty (Sahoo *et al*., 2020). Against this backdrop, this study attempts to analyze the extent and pattern of crop diversification, its contribution to farm income growth, and future prospects for diversification-led growth. This has implications for (re)allocation of resources among crops and thus probes into a vital research question "whether or not the crop diversification can lead to agricultural transition".

The rest of this paper is divided into four sections. The following section deals with the data and methodology for quantifying the contribution of crop diversification to agricultural growth. Section 3 discusses the sources of growth. The final section summarises key findings and provides a few policy prescriptions to accelerate crop diversification.

2. DATA SOURCES

The secondary data used in the study have been taken from *Odisha Agriculture Statistics* (OAS), published annually by the *Directorate of Agriculture and Food Production*, Government of Odisha (GoO). This is the only reliable dataset from the state government on various aspects of Odisha agriculture. The dataset mainly publishes, for each year, district-wise area, productivity, and production of different crops, land utilization pattern, use of fertilizers, farm mechanization, and weather parameters such as rainfall, humidity, irrigation, and so on. We have used annual crop-wise data on area, production, productivity and prices from 1993-1994 to 2018-2019. Furthermore, major crops such as cereals, pulses, oilseeds, fibres, vegetables, spices, sugarcane, tobacco, fruits and flowers have been compiled for our analysis by clubbing together crops that fall under these headings. The historical series on "farm harvest prices" (FHP) for

[1] High-value farm commodities include profitable cash crops like fruits, vegetables, pulses, and dairy products, poultry, fish, and processed food (Ravi, Roy, 2006; Birthal *et al*., 2007). Basically, a high-value crop is one that enjoys a high demand in the market with relatively higher price than staples. In this study, we consider pulses, vegetables, oilseeds, sugarcane, fibres and floriculture as high-value agriculture. It also includes horticulture, animal husbandry and aquaculture, etc., which fetch higher income for the farmers.

each crop has been collected from the *Directorate of Economics and Statistics* (DES), GoO.

Temporal changes in the cropping pattern and expansion of the area under cultivation of different crop groups *prima facie* provide an initial indication of the extent and pattern of crop diversification. Hence, we compare these indicators at different time points: triennium ending (TE) 1995-1996, TE 2001-2002, TE 2009-2010, and TE 2017-2018. The selection of these time points has been guided by data availability and structural breaks in agricultural growth. The complete dataset on agricultural indicators at the district level is available from 1993-1994 onwards. This initial time point coincides with the beginning of economic reforms in India; hence it serves as a proper reference to understand the dynamics of agriculture in the post-reform period. The next time point, i.e., TE 2001-2002, is considered on the grounds that the year 2002-2003 was a drought year in India, including the state of Odisha. Therefore, the period after 2002-2003 is considered a period of outstanding performance of agriculture. Interestingly, the year 2008 witnessed a global food price spike, but India's food economy was not much influenced by it (Acharya *et al.,* 2012).

3. EMPIRICAL STRATEGY

Several measures can be used to understand the degree of diversity in the cropping pattern. We use the Herfindahl index, a widely used measure[2]. It can be expressed as:

$$HI = \sum_{i=1}^{n} P_i^2 \tag{1}$$

where $P_i = A_i / \sum_{i=1}^{n} A_i$ and P_i is the proportion of area under ith crop in the total cropped area. The value of HI lies between 0 and 1; 0 indicates complete diversification, and 1 shows complete concentration.

3.1. Diversification and Agricultural Transition: First Decomposition

Crop diversification can be defined as a shift of resources, especially land, from low-value to high-value crops to maximize income gains from cultivation (Birthal *et al.*, 2007; Joshi *et al.*, 2007; Dasgupta, Bhaumik, 2014). We can observe this transition in land use by decomposing the change in the gross cropped area as an "expansion effect" and a "substitution effect" (Dasgupta, Bhaumik, 2014). Formally, it is expressed as:

$$\Delta A^i = A_t^i - A_0^i = \left[\left(\frac{A_0^i}{A_0}\right)(A_t - A_0)\right] + \left[(A_t^i - A_0^i) - \left\{\left(\frac{A_0^i}{A_0}\right)(A_t - A_0)\right\}\right] \tag{2}$$

where, A_t is the gross cropped area (GCA) in year t, A_0 is the gross cropped area in the initial year, and A_t^i and A_0^i stand for the cropped area under ith crop in year t and initial year, respectively. The first bracketed term on the right-hand side of Eq. (2) represents the expansion effect (defined as the share of ith crop in GCA in the initial year times the change in GCA between year t and the initial year. In other words, it is the increase in area under ith crop because of an increase in GCA. The second bracketed term, the residual between the total change in area under a crop and its expansion effect, gives the substitution effect, indicating land diversion from low-value to high-value crops. Thus, there would be a strong and positive substitution effect for incoming crops and a strong negative substitution effect for outgoing crops (De, 2003; Dasgupta, Bhaumik, 2014). A strong positive substitution effect, together with the expansion effect, suggests a transition from traditional to modern commercial agriculture.

3.2. Sources of Farm Income Growth and Diversification: Second Decomposition

We follow the decomposition method developed by Minot (2003) that provides for the contribution of area expansion, yield improvements, price increases and area reallocation (or diversification) to farm income growth[3]. Some recent studies, like Joshi *et al.,* (2006) and Pandey & Kumari (2021) have adopted this method.

Denoting the area under ith crop as A_i, its real price as P_i and yield as Y_i, the total farm income/revenue (R) from "n" crops can be expressed as:

$$R = \sum_{i=1}^{n} A_i Y_i P_i \tag{3}$$

Expressing $a_i = A_i / \sum_i A_i$, i.e., the share of ith crop area in the gross cropped area, the Eq. (3) can be rewritten as:

$$R = \left(\sum_{i=1}^{n} a_i Y_i P_i\right) \sum_{i=1}^{n} A_i \tag{4}$$

[2] There are other measures of diversification like the Simpson Diversity index, Margalef index, Gini-Simpson Index, Ogive index, Berger-Parker index, Shannon index, Entropy index, etc. But, Herfindahl index is used because it is the simplest and most widely used measure of crop diversification. This measure is closely associated with the Simpson index.

[3] Gross farm income is defined as the income from the crop production as the value of crop production. Since some portion of the total output is not marketed, this includes both cash and in-kind income.

Now, the change in gross farm income, taking the total change on both sides, can be expressed as:

$$\Delta R \cong (\sum_{i=1}^{n} a_i Y_i P_i)\Delta(\sum_{i=1}^{n} A_i) + (\sum_{i=1}^{n} A_i)\Delta(\sum_{i=1}^{n} a_i Y_i P_i) \quad (5)$$

Eq. (5) provides approximate contributions of different sources to agricultural growth as it ignores the contributions of interactions of different sources. The second term on the right-hand side of Eq. (5) can be further decomposed from a "change in sums" to the "sum of changes".

$$\Delta R \cong (\sum_{i=1}^{n} a_i Y_i P_i)\Delta(\sum_{i=1}^{n} A_i) + (\sum_{i=1}^{n} A_i) \sum_{i=1}^{n} \Delta (a_i Y_i P_i) \quad (6)$$

Further manipulation of the second term in Eq. (6) gives the following equation:

$$\Delta R \cong (\sum_{i=1}^{n} a_i Y_i P_i)\Delta(\sum_{i=1}^{n} A_i) + (\sum_{i=1}^{n} A_i) \sum_{i=1}^{n} (a_i Y_i \Delta P_i) + (\sum_{i=1}^{n} A_i) \sum_{i=1}^{n} (a_i P_i \Delta Y_i) + (\sum_{i=1}^{n} A_i) \sum_{i=1}^{n} (P_i Y_i \Delta a_i) \quad (7)$$

The first term on the right-hand side of Eq. (7) denotes the change in gross farm income due to the change in total cropped area or GCA. The second term represents the effect of change in real price, and the third term indicates the effect of change in crop yields. Finally, the fourth term shows the effect of area reallocation, and if this term is positive, then there is diversification from lower-value to higher-value crops.

4. CROPPING PATTERN AND GROWTH DYNAMICS OF ODISHA AGRICULTURE

4.1. Changes in cropped area

Let us begin with an analysis of the changes in cropping patterns (Tab. 1). Overall, the GCA has been shrinking but erratically. The area under foodgrain crops witnessed a slight increase, and that under non-food grain crops a marginal decrease. The area under oilseeds, vegetables, spices, sugarcane and tobacco has declined. On the other hand, the area under fruits and fibres has increased. In fact, fruits have gained substantially in their area share, from 2.7% in TE 1995-1996 to 3.6% in TE 2001-2002, and further to 6.4% in TE 2017-2018. The area share of fibre crops more than doubled, from 0.8% in TE 1995-1996 to 1.8% in TE 2017-2018. The change in share of foodgrains initially registered an increase but subsequently declined. In TE 1995-1996, it stood at 73.9%, which increased to 77.9% in TE 2001-2002 but after that decreased continuously, reaching 74.5% in TE 2017-2018. Despite these dynamics, the area share of foodgrains has, by and large, remained stable.

Foodgrains occupy a significant chunk of cultivable land in Odisha; hence, we further look into the dynamics of change in different foodgrain crops. Appendix Table A.1. shows that cereals account for about 70 percent of the total area under foodgrains and pulses the rest. Amongst cereal crops, rice is the dominant crop and shares more than 62 percent of the foodgrain area. Among other crops, green gram, black gram, horse gram and arhar are important pulses grown in the state.

It is generally perceived that crop diversification happens when there is an increase in the area share

Tab. 1. Change in Cropping Pattern in Odisha.

	Average Area (in '000 hectares)				Share in Total Cropped Area (%)			
Crop Heads	TE 1995-1996	TE 2001-2002	TE 2009-2010	TE 2017-2018	TE 1995-1996	TE 2001-2002	TE 2009-2010	TE 2017-2018
Food –Grains	7173.8	6544.1	6905.6	6284.3	*73.9*	*77.9*	*76.3*	*74.5*
Oilseeds	1127.9	801.6	822.3	621.6	*11.6*	*9.5*	*9.1*	*7.4*
Vegetables	827.8	468.1	675.0	651.2	*8.5*	*5.6*	*7.5*	*7.7*
Fruits	266.8	302.4	369.2	540.1	*2.7*	*3.6*	*4.1*	*6.4*
Fibres	74.3	98.8	93.0	151.8	*0.8*	*1.2*	*1.0*	*1.8*
Spices	178.4	149.0	147.2	160.9	*1.8*	*1.8*	*1.6*	*1.9*
Sugarcane	43.3	30.7	37.6	27.8	*0.4*	*0.4*	*0.4*	*0.3*
Tobacco	9.8	5.5	3.7	0.8	*0.1*	*0.1*	*0.04*	*0.01*
Non-foodgrain	2528.3	1856.0	2148.0	2154.3	*26.1*	*22.1*	*23.7*	*25.5*
GCA*	9702.1	8400.1	9053.6	8438.6	*100*	*100*	*100*	*100*

Note: TE implies a Triennium ending. The asterisk (*) indicates that GCA includes the area under fruits.
The sum of shares is 100, which is calculated by taking the broad groups.

of non-foodgrains high-value cash crops. But some foodgrains like pulses and basmati rice are considered high-value crops. Appendix Table A.2. presents broad categories of non-foodgrain crops, such as oilseeds, fibres, spices and vegetables, with significant shares in the total cropped area. Oilseeds have the highest share in the total non-foodgrain areas, but their share has continuously declined, from around 50 until TE 2001-2002 to 42.4 percent in TE 2017-2018. The area share of groundnut, linseed and mustard has remained almost stagnant within the oilseeds, while that of sesamum and niger declined. On the other hand, the area share of fibres increased considerably from 3.3 percent in TE 1995-1996 to 8.1 percent in TE 2017-2018. This was driven by cotton. The area share of vegetables and spices (e.g., chilly and turmeric) also increased.

4.2. Dynamics of Agricultural Growth

Table 2 presents production of different crop groups and growth therein. Between TE 1995-1996 and TE 2001-2002, the growth rates in production of all crop groups were negative, except for spices and sugarcane. Production of pulses, oilseeds, vegetables and fibres declined faster. Nonetheless, the trend reversed in the subsequent period, and most crop groups experienced positive growth between TE 2001-2002 and TE 2009-2010. The production of cereals and pulses grew at an annual rate of 3.4% and 5.6%, respectively. Vegetables grew at 7.4% and spices at 4% during the same period. The growth in production of most crops decelerated in the recent period.

Combining the observations from Tables 1 and 2, we can draw certain inferences. First, the area under foodgrains' growth rates is lower than the growth rate of foodgrains' production between TE 2001-2002 and TE 2009-2010, and between TE 2009-2010 and TE 2017-2018. It may be due to an increase in the productivity of foodgrains. Similar phenomena are observed in the case of oilseeds, vegetables and spices, which imply an increase in these categories of crops' productivity. Second, as far as fibres are concerned, the production growth rate is higher than the area's growth rate between TE 2001-2002 and TE 2009-2010, suggesting an increase in fibres' productivity during this period. On the other hand, between TE 2009-2010 and TE 2017-2018, the growth rate of area is very high compared to the growth rate of fibres' production, suggesting a decrease in productivity.

5. EMPIRICAL RESULTS AND DISCUSSION

5.1. Extent of Diversification and Agricultural Transition

Table 3 reports the values of the Herfindahl index (HI) for the agriculture of Odisha. Excluding the area under fruits and flowers, the value of HI reveals that the level of crop diversification in Odisha's agriculture has fallen marginally over time. HI's value was 0.25 in 1995-1996 but increased to 0.32 in 2001-2002, implying a significant diversification decline during this period. Since then, it has improved slightly as the HI value reached 0.29 in 2009-2010 and further declined to 0.27 in 2017-2018, implying a slight improvement in the extent of

Tab. 2. Average production and compound growth rates of different crop groups.

Crop Group	TE 1995-1996	TE 2001-2002	TE 2009-2010	TE 2017-2018	GR between 1995-1996 & 2001-2002	GR between 2001-2002 & 2010-2009	GR between 2009-2010 & 2017-2018
Total Cereals	6887.1	6058.2	7910.2	8261.7	*-2.1*	*3.4*	*0.71*
Total Pulses	1154.4	619.2	955	1003.4	*-9.9*	*5.6*	*0.72*
Foodgrains	8041.5	6677.5	8865.2	9265.1	*-3.1*	*3.6*	*1.28*
Oilseeds	852.1	493.7	666	553.4	*-8.7*	*3.8*	*-1.92*
Vegetables	6996.6	4812.7	8512.1	9006.5	*-6*	*7.4*	*2.03*
Fibres*	473.1	311.6	383.8	478.5	*-6.7*	*2.6*	*4.07*
Spices	194.3	200.3	274	588.9	*0.5*	*4*	*10.73*
Sugarcane	289.2	1940	2652.1	2035.6	*37.3*	*4*	*-2.86*
Tobacco	5.9	3.4	2.8	0.5	*-8.9*	*-2.5*	*-9.14*

Note: (1) * is in '000 bales. Other quantities are in '000 tonnes. (2) GR is the average annual compound growth rate defined as $g = e^{\left(\frac{1}{t} * Ln\left(\frac{Y_T}{Y_0}\right) - 1\right) * 100}$; Y_T and Y_0 are starting and ending values of the concerned variable, and "t" represents the number of years between two time periods (in our case TE periods). For spices, sugarcane and tobacco, production data for 1995-1996 is the average of 1994-1995 and 1995-1996 data due to their data unavailability for 1993-1994.

Tab. 3. Extent of crop diversification in agriculture of Odisha.

TE Periods	HI excluding Fruits & Flowers	HI including Fruits & Flowers*
1995-1996	0.25	0.24
2001-2002	0.32	0.30
2009-2010	0.29	0.26
2013-2014	0.28	0.23
2017-2018	0.27	0.25

Note: * TE 1995-1996 & 2001-2002 includes the area under fruits only since the area under flowers is not available for these periods. TE 2009-2010 onwards consists of both fruits and flowers area.

diversification. However, it is still less than the level it used to be at in 1995-1996. After including all crops, the HI estimates that the extent of diversification naturally came out higher. The initial value was at 0.24 in 1995-1996 but increased to 0.30 in 2001-2002. However, it grew to 0.26 in 2009-2010 and then further decreased to 0.23 in 2013-2014 but again increased to 0.25. So, in recent times, the extent of agricultural diversification has declined. This result has been supported by Nayak & Kumar (2019). They argue that the wide use of high-yielding varieties (HYVs) and access to irrigation in coastal districts have rendered crop diversification sluggish in Odisha agriculture.

From the preceding analysis, we obtain the extent and pattern of agricultural diversification over time, suggesting that it was around 0.75 during the mid-1990s and then started falling. However, recently it increased but still below the level of the mid-1990s. So, we can conclude that there is a marginal decline in diversification. Here, we analyze the source of diversification, i.e., whether the change in area is from the expansion of gross cropped area or intercrop substitution of area. Table 4 gives the decomposition of the total change in the area into expansion and substitution effects. It is important to recall that the GCA in Odisha was 9747.29 thousand hectares in 1993-1994, which declined to 8636.59 thousand hectares in 2003-2004 and became 9054.07 thousand hectares in 2009-2010, which again fell to 8206.94 in 2017-2018. It can be seen from Table 5 that, between 1993-1994 and 2003-2004, the total change in area under all crops except fibres and fruits is negative. However, there is a strong positive substitution effect in the case of cereals, fibres and total fruits, which indicated that farmers were substituting other crops with cereals, mainly paddy. There was a significant decline in the area under pulses, oilseeds and vegetables, where there was a substantial negative expansion as well as a substitution effect. In the more recent period, between 2003-2004 and 2013-2014, the total change in area under pulses was positive with sizeable positive expansion and substitution effect. At the same time, the total change in area under cereals fell with a strong negative substitution effect. During this period, the total change in area under fibres, vegetables, spices and fruits increased positively, with positive expansion as well as substitution effect. This implies that these crops, along with pulses, were substituting other crops in Odisha. In the most recent period between 2013-2014 and 2017-2018, total area change for almost all crops was negative. However, cereals and pulses experienced a positive substitution effect, but a strong negative expansion effect outweighed it. This means that these crops were replacing other crops even though the total area under these crops was falling. We observed similar dynamics in crop

Tab. 4. Decomposition of the total change in area in Odisha (area in '000 ha).

Crop Groups	TE 1993-1994 to 2003-2004			TE 2013-2014 to 2003-2004			TE 2017-2018 to 2013-2014		
	EE	SE	TC	EE	SE	TC	EE	SE	TC
Cereals	-578.0	431.2	-146.8	238.1	-495.4	-257.3	-436.8	76.6	-360.1
Pulses	-242.6	-244.0	-486.7	79.4	366.2	445.6	-195.4	73.4	-122.0
Oilseeds	-127.1	-192.5	-319.7	38.5	-82.2	-43.7	-70.4	-60.4	-130.8
Fibres	-7.6	23.3	15.7	4.0	65.9	69.9	-14.2	14.1	-0.1
Vegetables	-97.0	-109.5	-206.5	31.2	1.2	32.4	-63.4	37.3	-26.1
Spices	-19.7	-8.6	-28.3	29.9	-11.8	18.2	-14.5	15.8	1.3
Sugar Cane	-4.4	-5.7	-10.1	1.4	5.2	6.6	-3.3	-4.2	-7.5
Tobacco	-1.1	-3.6	-4.7	0.3	-3.9	-3.6	-0.2	0.2	0.1
Total Fruits	-32.5	114.8	82.3	17.7	138.8	156.6	-49.0	-160.2	-209.2
Total Flowers*	--	--	--	0.02	4.9	4.9	-0.5	1.8	1.3

Note: (1) EE-expansion effect, SE-substitution effect, and TC-total change. (2) NA-not available.
Odisha.

area changes in the case of fibres, vegetables and spices. Surprisingly, the area under fruits fell with negative expansion as well as substitution effect.

Thus, this analysis demonstrates a negligible agricultural transition from traditional food crops to the modern state of non-food crops by substituting the crop area. But as such, there is no change in the degree of diversification. Banerjee & Banerjee (2015) and Nayak & Kumar (2019) also found the same in the case of Odisha. So, Odisha agriculture continues to be in a low growth state with the static spread of cropping patterns over time. This fact makes Odisha agriculture unsustainable because without expansion of gross cropped area with the static spread of crops does ensure a high exposure of farmers to various types of farming risks such as market/price risks, income risks as well as climatic risks (Paltasingh, Goyari, 2011; Birthal, Hazrana, 2019).

Again, this low degree of diversification causing a negligible agricultural transition towards high-value agriculture is deleterious to Odisha agriculture. Because the state's agricultural sector is replete with smallholders but substantial surplus labour, this transition could be a boon for the smallholders to augment their income as most of these high-value commodities are labour-intensive with low gestation periods that give quick returns (Birthal *et al.*, 2007; Barghouti *et al.*, 2004). We also have credible evidence of an inverse relationship between farm size and productivity in the case of high-value crops (Birthal *et al.*, 2014), which is absent in the case of other crops. Hence, Odisha agriculture could highly benefit from this move. Diversification is also a major driver of farm investment and farm productivity (Akber, Paltasingh, 2021). In this context, we have success stories in other Indian states like Punjab and Andhra Pradesh (IFPRI, 2007). In Punjab, there is diversification towards the dairy sector, though the rice-wheat system still dominates. But Andhra Pradesh has been more diversified toward fisheries, poultry, fruits and vegetables, replacing the core cereals and, to some extent, rice.

5.2. Sources of Farm Income Growth & Diversification

Table 5 presents the decomposition of farm income growth into various sources: total cropped area, yield, prices and crop diversification. Here, we observed the contribution of different factors in farm income growth during two decades: TE 1995-1996 to TE 2007-2008 and TE 2007-2008, and TE 2017-2018. Initially, the contribution of the growth of real price and the growth of yields, and the combined contribution (interaction effect) significantly determined farm income growth. First, there was a significant price effect, followed by the yield effect.

Tab. 5. Contribution of various components to farm income growth for crop groups (in %).

Changes in Gross Crop Income due to	Between TE 1995-1996 to TE 2007-2008	Between TE 2007-2008 to TE 2017-2018
ΔTotal Cropped Area	*-25.9*	*-5.4*
Δ Real Price	*96.1*	*69.4*
Δ Crop Yields	*14.1*	*12.0*
Δ Area Composition	*3.7*	*2.2*
Interaction	*12.0*	*21.8*
Total	*100*	*100*

Note: (i) Major crops include paddy, wheat, ragi, maize, mung, Biri, Kulthi, mustard, groundnut, til, jute, sugarcane and potato; (ii) Share of these commodities in total cropped area of Odisha for TE 1995-96, TE2007-08, and TE 2017-18 stood at 87 percent, 83 percent, and 81 percent, respectively; (iii) District level data on Farm Harvest Prices (FHP) for calculation of the value of these crops are used as the value of Odisha agriculture. This dataset is available on https://agriodisha.nic.in/Home/staticstics. (iv) We calculate the weighted average FHP for each crop for Odisha by taking each district's crop-wise production as weight.

In the subsequent decade, i.e., TE 2007-2008 to TE 2017-2018, farm income growth was also mainly determined by the same set of factors, but the interaction effect turned out to be a major one. There is a slight decline in yield effect that may be attributed to the declining contribution of yield in crop income growth on account of a reduction in yield growth for most crops, including rice, as evident earlier (Tab. 3). Pandey & Kumari (2021) also evidenced the same in the case of Jharkhand, another poor state in Eastern India. They found a significant price effect (41%) in the later period. Joshi *et al.,* (2006) also found the same at the aggregate level of Indian agriculture. However, the effect of diversification was meagre in the initial period, which again declined. This is in line with earlier results observed that there is a decline in the degree of diversification. So, we obtain a negative contribution of crop diversification. It implies that the agriculture of Odisha has been static, and there is no transition towards high-value crops. Again, the decline in yield effect poses a serious question about the viability of output and farm income enhancement. Because the improvement in crop yields represents technological advancement (Birthal *et al.*, 2014; Pandey, Kumari, 2021), while the price effect signifies the market contribution in a narrow sense, this suggests that farm income is increasingly and mainly driven by only the price increases, not by technological improvements or diversification. When market contribution is necessary, technological advancements (yield effect) and agricultural transition (diversification towards high-value crops) make farm income growth sustainable and stimulates

higher farm investment (Akber, 2022). But in Odisha agriculture, both are missing as it is significantly out of rising real prices. As observed earlier, the negative area effect further exacerbates the condition. Therefore, farm income growth is not sustainable in state agriculture, which calls for urgent policy intervention.

6. CONCLUSION AND POLICY IMPLICATIONS

From the above analysis, we observed a fall in the total cropped area. However, the extent of the decline in the area under non-foodgrains is relatively lower than that of foodgrains. Again, there is hardly any change in the relative share of area under foodgrains and non-foodgrains in the total cropped area over the years. The cropping pattern in Odisha, primarily biased towards cereals, has remained static over the period. In the case of area occupied, rice, among cereals, is still the dominant crop in Odisha. Maize and Ragi are the other two significant cereal crops.

The value of HI, including fruits and flowers, was at 0.24 in 1995-1996 and increased to 0.312 in 2002-2003. But since then, it has declined, first to 0.26 in 2009-2010 and then further to 0.25 in 2017-2018. So, in recent periods, fruits and flowers have led to a marginal increase in the extent of crop diversification in Odisha. But overall, there is a moderate to low degree of diversification in the agriculture, and much worse is the fact that it has remained stagnant over the last two decades. Hence, the agricultural transition looks gloomy because of marginal crop diversification due to increased area under vegetables, fruits and flowers. Therefore, the transition from traditional to modern high-value agriculture is almost absent. The substitution effect is negative for nearly all crops, while the expansion effect is relatively weak (only fibres, fruits, vegetables and flowers).

In fact, the agriculture of Odisha continues to reel under the traditional form where a heavy bias towards rice is found, making it highly vulnerable to both biotic and abiotic risks. Again, crop income growth in the agriculture is majorly determined by the unsustainable price effect. When the contribution of yield growth is not that substantial, the role of crop diversification in farm income growth has been meagre over the last two decades. It's only because of the static cropping pattern, which renders the agriculture of Odisha a subsistence sector.

The paper suggests some policies for the development of Odisha agriculture along with directions for future research. First, the low and almost stagnant level of crop diversification in agriculture should be addressed. The farmers need to be encouraged through various schemes, awareness programmes, and farmers' field schools (FFS) about the importance of diversification in their cropping pattern. Second, the declining contribution of yield and diversification must be viewed seriously in the policy circle because both have been declining over the years. Hence, there is a huge need for public investment in irrigation, transport, marketing, storage, etc. Because this will stimulate private investment at farm level in the form of the adoption of modern yield-enhancing technology, as well as encourage farmers to adopt a mix of cropping patterns to reduce risks. Again, traditional indigenous cropping patterns consisting of pulses and millets should be promoted in dry uplands. Recently, a programme called "millet mission" was launched, but it should be promoted massively in dry regions of the state. Diversifying towards a remunerative crop mix augments rural farm income, creates more employment opportunities, and empowers the downtrodden, especially rural women (Pingali, Rosegrant, 1996; Ryan, Spencer, 2001; Joshi *et al*., 2006). Third, the already weakened agricultural extension and market information system must be emphasized to achieve all this. Fourth, other institutional arrangements must be implemented to enhance all markets' vertical coordination, adequate crop procurement, and arrest crop losses due to their perishability.

This study can be considered as the basis for further research on various issues relating to crop diversification, such as why there is a low level of crop diversification in the state's agriculture. How can it be promoted, and is diversification towards high-value crops effective in augmenting farm income, reducing rural poverty and coping with climatic shocks? These are some of the research issues that can be addressed.

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APPENDIX

Tab. A.1. Crop-wise distribution of total food grain area in Odisha (in %)

Crops	Share in Total Food grain Area			
	TE 1995-1996	TE 2001-2002	TE 2009-2010	TE 2013-2014
(A) Cereals	*70.0*	*75.6*	*70.9*	*69.0*
Rice	*62.9*	*68.8*	*64.3*	*61.7*
Wheat	*0.3*	*0.3*	*0.3*	*0.2*
Jowar	*0.3*	*0.2*	*0.1*	*0.1*
Bajra	*0.1*	*0.1*	*0.0*	*0.0*
Maize	*2.3*	*2.6*	*3.2*	*4.2*
Ragi	*3.2*	*3.0*	*2.7*	*2.6*
Small Millets	*0.9*	*0.6*	*0.3*	*0.3*
(B) Pulses	*30.0*	*24.2*	*29.1*	*31.0*
Arhar	*2.3*	*2.1*	*2.0*	*2.1*
Mung	*10.6*	*8.8*	*11.3*	*12.6*
Biri	*8.3*	*7.5*	*8.9*	*9.0*
Kulthi	*5.2*	*4.3*	*3.7*	*3.5*
Gram	*0.5*	*0.4*	*0.6*	*0.6*
Fieldpea	*0.3*	*0.4*	*0.4*	*0.5*
Lentil	*0.1*	*0.2*	*0.2*	*0.2*
Cowpea	*0.3*	*0.4*	*1.1*	*0.8*
Other Pulses	*2.4*	*NA*	*1.2*	*1.7*
Total Food grains*	*7171.8*	*6544.0*	*6884.6*	*6600.0*

Note: * Figures are in '000 Hectares; NA- not available

Tab. A.2. Crop-wise distribution of total non-food grain area in Odisha (in %).

Crops	Share in Total Non-Food Grain Area			
	TE 1995-1996	TE 2001-2002	TE 2009-2010	TE 2013-2014
(A) Oilseeds	*50.0*	*51.6*	*46.2*	*42.4*
Groundnut	*14.1*	*15.0*	*14.1*	*14.7*
Sesamum	*16.5*	*16.5*	*16.6*	*12.7*
Caster	*1.2*	*1.3*	*1.0*	*0.7*
Niger	*9.0*	*9.4*	*5.8*	*4.2*
Sunflower	*0.1*	*0.5*	*1.0*	*1.4*
Safflower	*0.2*	*0.2*	*0.1*	*0.0*
Linseed	*1.4*	*1.5*	*1.5*	*1.3*
Mustard	*7.4*	*7.2*	*6.2*	*7.3*
(B) Fibres	*3.3*	*6.3*	*5.2*	*8.1*
Jute	*0.9*	*0.9*	*0.6*	*0.6*
Mesta	*1.5*	*1.7*	*1.1*	*0.8*
Sun hemp	*0.6*	*0.7*	*0.5*	*0.4*
Cotton	*0.3*	*3.0*	*3.0*	*6.4*
(C) Vegetables	*36.7*	*30.1*	*37.9*	*38.5*
Sweet Potato	*2.3*	*2.6*	*2.7*	*2.4*
Potato	*0.4*	*0.5*	*0.5*	*0.8*
Onion	*2.1*	*2.0*	*1.7*	*2.0*
Other Vegetables	*31.8*	*25.0*	*32.9*	*33.3*
(D) Spices	*7.8*	*9.6*	*8.3*	*8.7*
Chilly	*4.4*	*5.2*	*4.2*	*4.3*
Coriander	*1.1*	*1.1*	*1.1*	*1.1*
Garlic	*0.8*	*0.8*	*0.6*	*0.7*
Turmeric	*1.0*	*1.7*	*1.4*	*1.6*
Ginger	*0.5*	*0.6*	*0.9*	*1.0*
(E) Sugar Cane	*1.8*	*2.0*	*2.1*	*2.1*
(F) Tobacco	*0.5*	*0.3*	*0.2*	*0.1*