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**AGRICULTURAL PRODUCTIVITY IN SOUTH AFRICA:
LITERATURE REVIEW.**

BY

**DIRECTORATE: ECONOMIC SERVICES
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Preview

*The report is organised in five sections. The **first section** gives a background of agricultural productivity in South Africa and an indication of why the report has been compiled; the **second section** provides an understanding of what the report aims to achieve; the **third section** provides a detailed analysis of the historical context of South Africa's agricultural productivity and gives a perspective of factors underlying agricultural productivity in South Africa; the **fourth section** outlines empirical analysis of studies that indicate the extent to which agricultural productivity has been evolving over time at international, African and South-African levels; and finally, the **fifth section** of the paper covers data needs and gaps, provides a few concluding remarks, followed by recommendation of areas for further research.*

Content

1	Introduction and background.....	4
2	Objectives and organisation of the report.....	5
3	Agricultural productivity in South Africa.....	6
3.1	Historical overview.....	6
3.1.1	Total agricultural productivity.....	6
3.1.2	Agricultural input productivity.....	8
3.1.3	Agricultural enterprise productivity.....	8
3.2	Factors affecting agricultural productivity.....	9
3.2.1	Agricultural output.....	9
3.2.2	Agricultural input.....	10
4.	Literature review on agricultural productivity.....	12
4.1	Research methodologies.....	12
4.2	Review of studies.....	13
4.2.1	International studies.....	13
4.2.2	Studies in Africa and South Africa... ..	18
5.	Data needed and gaps.....	22
6.	Summary of findings.....	24
7.	Conclusion and recommendation.....	25
8.	Bibliography.....	27

1. Introduction and background

The Department of Agriculture (now Department of Agriculture, Forestry and Fisheries) has been involved in improving agricultural production and minimizing the cost of inputs of farmers for decades. According to Kirsten *et al* (2003) government supported farmers with debt consolidation subsidies of R344 million, crop production loans of R470 million, drought relief of R120 million and acted as a guarantor of consolidated debt of R900 million in the eighties and early nineties. All this was done to increase the productivity of farmers.

The support however changed around the mid nineties where government reduced funding to commercial sector in bid to improve the efficiency and productivity of the sector. Also government started the support to the small-scale farming sector which continued even at the advent of democracy. Government supported small-scale farmers through homeland consolidation and trust land purchases in the 1970`s, microeconomic deregulation process which increased the marketing of informal farm products in the economy in the 1968; creation of a land reform process that guaranteed and increased ownership of land for production in 2000, promulgation of new Water Act of 1998 that increased access to water by the land owners in the rural areas and revival and upgrading of old water scheme infrastructure in rural areas (Vink *et al*, 2002).

Agricultural productivity measures the performance and provides a guide to the efficiency of the sector (Thirtle *et al* (1993); Thirtle *et al* (2005); Kirsten *et al* (2003) and Conradie *et al* (2009)). Even United States Department of Agriculture (1980) stated that agricultural productivity statistics are important to identify the source of economic growth, justify the appropriation of agricultural research funds, serve as an indicator of technical changes and justify price changes. Although government's involvement was limited to creating policy instruments

that improved productivity within the sector, its involvement on researching about the productivity was limited.

Research on productivity was within the hands of research institutions such as Universities and other private organizations such as Productivity SA. It has come to the attention of DAFF that although most of the database used for productivity measurement resides within its jurisdiction (through Directorate Agricultural Statistics), a database on the trend of productivity estimates is not accessible as it resides within private research institutions. Having the updated information on agricultural productivity estimates that is easily accessible and understandable within the department can assist the department in continuously testing and questioning the validity/accuracy of the statistics produced by its own and other statistical services, thus ensuring a greater degree of consistency and quality in official statistics over time.

Also the information will not only enlighten DAFF to know the current status of productivity, factors affecting productivity and ways to improve on productivity but will assist DAFF to know whether the sector is competitive internally and globally. Also it will enlighten DAFF to understand if its spending or investment in the sector is worthwhile and as a result will enhance policies aimed at improving the productivity of the sector, to contribute to the national economy, and ultimately improve the lives of the poor.

The intention of this report is to compile secondary information that will path both a historical and current picture of agricultural productivity in South Africa and the methodologies used.

2. Objectives and organisation of the report

The overall objective is to analyse the shortcomings of the existing agricultural productivity studies, identify the constraints on the type of analysis and identify a

plan of action to address such constraints and shortcomings for future research in this area. Specifically, the study will do the following:

- Review literature on the current and historical trends of agricultural productivity in South Africa.
- Review international and local literature on the methodologies used to estimate agricultural productivity.
- Identify research gaps and make recommendations.

3. Agricultural productivity in South Africa

3.1 Historical overview

3.1.1 Total agricultural productivity

The trend of agricultural productivity in South Africa is traced back from 1910. Various authors (Liebenberg *et al* (2010); Conradie *et al* (2009); Nin *et al* (2003), Schimmelpfenning *et al* (2000) and Thirtle *et al* (1993)) have had interest in estimating agricultural productivity over the years. Estimates from all these studies have shown that over the years the productivity of the agricultural sector has been fluctuating. In some years it was stagnant whilst in some it was increasing either at an increasing rate or at a decreasing rate.

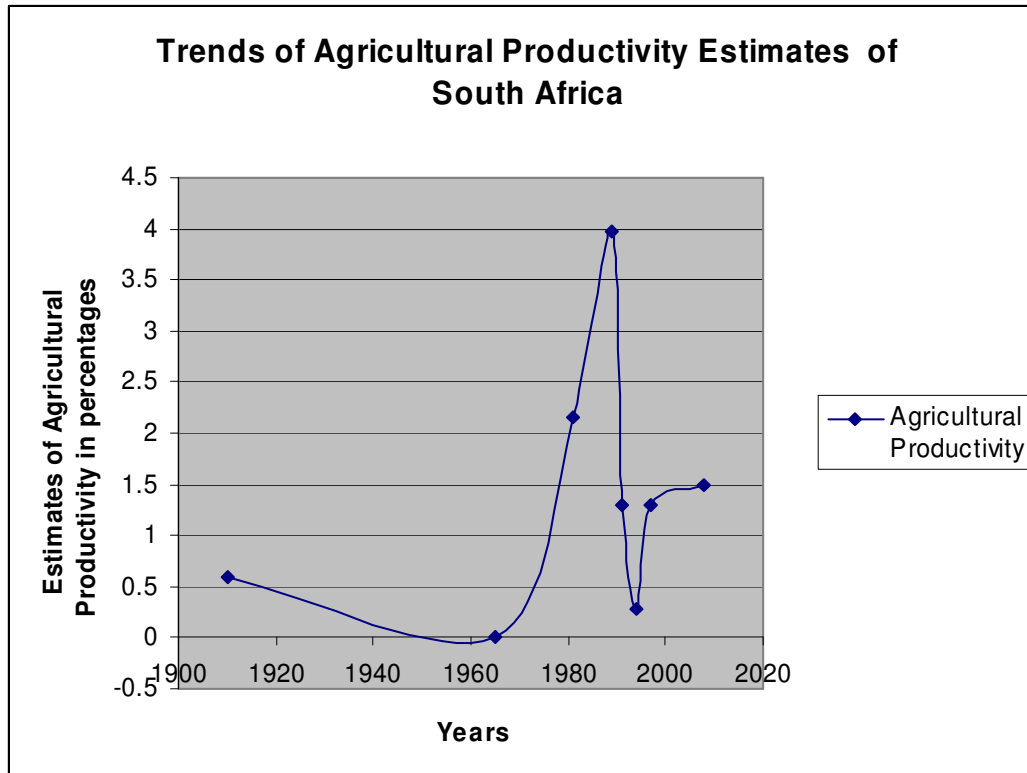


Figure 1: Agricultural Productivity Estimates from 1910-2008

Source: Own creation using (Liebenberg *et al* (2010); Conradie *et al* (2009); Nin *et al* (2003), Schimmelpfenning *et al* (2000) and Thirtle *et al* (1993))

Figure 1 above clearly shows that before 1965 growth of the agricultural productivity was estimated at 0.65% per annum. In 1965, there was no growth of productivity after which (1965 to 1981) growth increased by 2.15%. This was due to input prices which were rising faster than the output prices farmers received throughout the period in 1965 (Kirsten *et al*, 2003). However, it recovered to 2.15% in 1980's due to a quick adjustment of farmers to the effects of deregulation (Liebenberg *et al*, 2010). Productivity grew rapidly at 3.98% between 1981 to 1989 due to mechanization and use of fertilizer, herbicides, pesticides, etc. Farmers at this stage were no longer severely constrained by state intervention but had the ability to change the mix of inputs that are less costly after the deregulation phase (Thirtle *et al*, 1993). From 1989-1994 growth of productivity declined to even 0.28% due to inflation rates that had reached a

peak and the net farm income that was negative. But after 1994 the growth was positive due to a positive net farm income (Schimmelpfenning *et al*, 2000) and then it became stagnant due to declining output growth and increasing use of inputs around 2008 (Conradie *et al*, 2009).

3.1.2 Agricultural input productivity

Overall the growth rate of productivity of land grew by 2.49% per year slightly lower than the labour productivity that grew at 2.83% per year between 1911 and 2008. Even so, the productivity of both these inputs fluctuated over the years. Between 1911 and 1940 both labour and land productivity grew at a very slow pace of 0.89% and 1.89% per year (Liebenberg, 2008). The rate of growth of both land and labour productivity then peaked between 1947-1981 at an impressive 4.91% per year for labour productivity and 4.17% per year for land productivity. Since then it declined by 2.67% per year for labour and 1.46% per year for land.

Although land and labour productivity in South Africa has remained at 1.46% and 2.67% per year, this level remains high compared to other African countries. This is because the value of output per labour is considerably high in South Africa estimated at \$5,663 per worker since 2007. The rapid labour productivity is seen through an increase in agricultural output in South Africa of 1.35% per year from 1961-2007 (Wiebe *et al*, 1998).

3.1.3 Agricultural enterprise productivity

Overall the productivity of field crops and livestock production has increased slightly lower than horticultural output productivity. According to Liebenberg (2008) the productivity of field crops has been fluctuating over the years due to rainfall variation and recurring droughts. However, around 1910 corn yields has increased more than 4-fold, wheat yields by 4.4-fold and sorghum yield by 7-fold.

These yields declined drastically in the 30's, 80's and 90's due to recurring droughts in the country. In the twenty-first century the growth of yields of all these grains picked up due to increased mechanization, use of improved seeds, fertilizer, herbicides and pesticides. Livestock yields declined in the twenty-first century due to a decline in the number of livestock and shift in consumer preferences. Consumers demand leaner and much younger meat and this is more in pork and lamb. Also consumers demand more of livestock meat than other livestock products such as wool. The total number of sheep in the country has declined from 37.4 million head of sheep in 1996 to 21.9 in 2008.

3.2 Factors affecting agricultural productivity

There are various factors that can affect productivity either directly or indirectly. Agricultural output and input affect the growth of the productivity directly. However factors such as decreasing number of farmers, land reform and others can affect growth of productivity of the sector indirectly.

3.2.1 Agricultural output

According to Wiebe *et al* (1998) agricultural output grew at an average of 2.9% per year in South Africa in the 1980's whilst between 1960 and 1996 the growth slowed to 1.4%. This was due to policy changes around the 1980's which led to the removal of existing controls over the movement of labour, microeconomic deregulation which led to a significant increase in various activities in informal economy, the decline in the state spending in agriculture and lack of support on producer price of maize (Kirsten, 1988). In the twenty-first century the shift in the structure of the agricultural sector and agricultural production led to a further slow down of agricultural production by 0.19% (Liebenberg *et al*, 2010). The slow down of overall agricultural output is due to a drag in the overall field crops output which is outpaced by the growth in the horticultural sector, which is as a result of composition of market share (Groenewald, 1964). According to Wiebe *et al*

(1998) growth of horticultural output (fruits and vegetables) outpaced that of field crops and animal output by almost 0.5% since 1911.

Figure 2 below shows that in 1911 about 55% of the value of agricultural output was livestock products, 34% was field crops and 10% was horticulture. By 2008, livestock and field crops had shrunk to 44% and 28% of the agricultural output by value whilst horticulture had increased by 23% (Liebenberg *et al*, 2010).

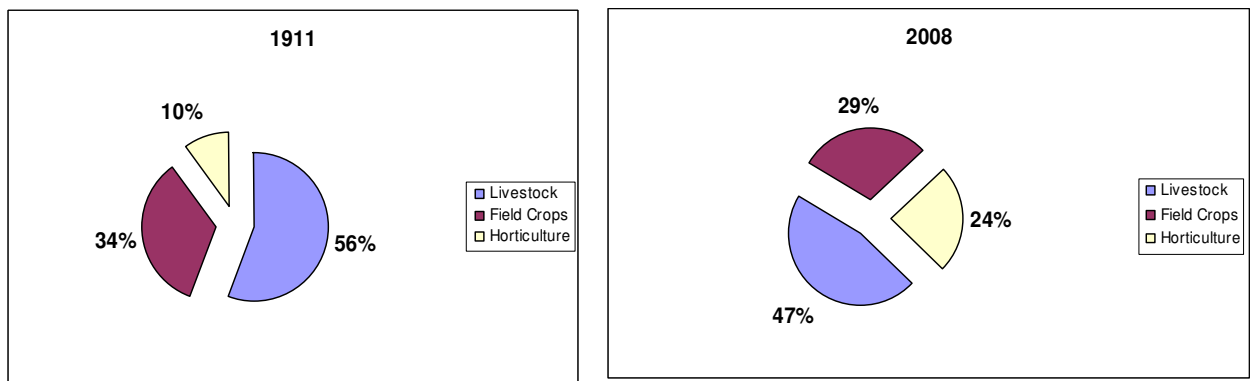


Figure 2: The Changing Composition of the Value of Agricultural Output

Source: Liebenberg *et al*, 2010.

3.2.2 Agricultural input

Agricultural inputs in general varied in terms of growth. There was a structural change in farmland use since 1910. Farmland grew by 91.8 million hectares in 1960, declining in 1996 to 82.2 million hectares and between 2000 and 2007 it has constantly remained within the range of 83.7 million hectares (Conradie *et al*, 2009). Black farmers' share of area farmed in 1918 and 1991 was 15% and in 2000 it doubled to 30%. The reason the share of black farmland area was small compared to that of commercial farmland was due to discriminatory policies in particular Land Act of 1913 which confined land ownership by black farmers to native reserves comprising 15% of the total agricultural land area in the country. The twenty-first century saw a declining number of farmers and a steady growth

of average farm size. In 1910 farm numbers and average farm size were estimated at 76,622 and 1,006 hectares respectively whilst in 2007 these were 44,575 and 1,400 respectively.

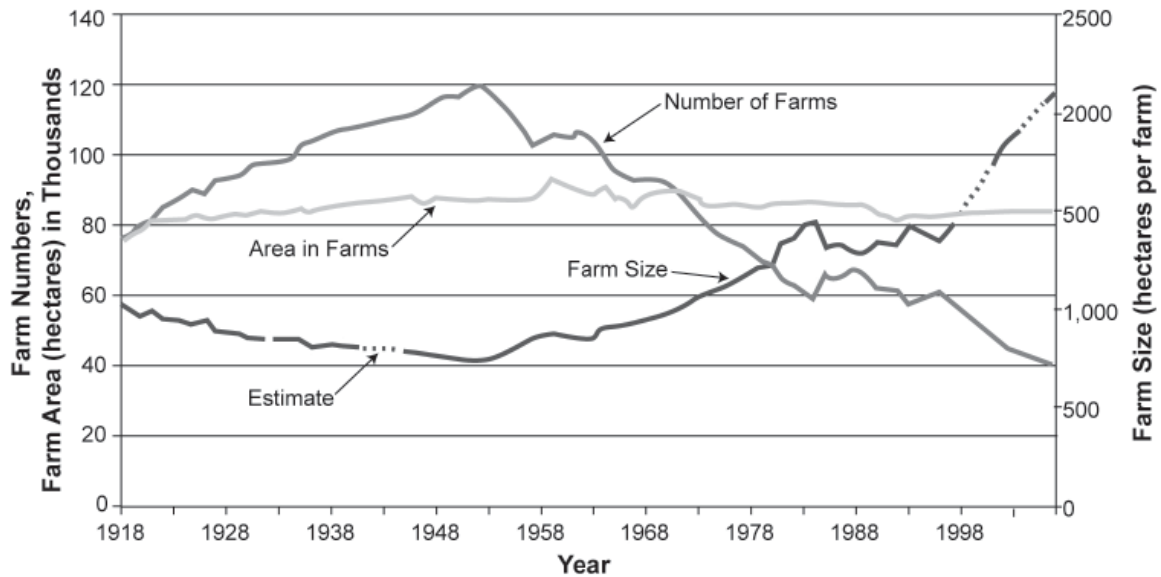


Figure 3: Farm Numbers, Farm Area (hectares) and Farm Size

Source: Liebenberg *et al*, 2010.

On the other hand intermediate inputs have increased since 1947/48; their share of total costs in 1947/48 was around 30% compared to 50% in 2006/2007. That being the case capital costs have increased within the same period whilst labour costs have reduced from 36% in 1947/48 to 15.1% in 2006/07. Land costs saw fluctuation over this period. In 1947/48 these were 6.6% and they grew to 15.55% and later declined to 3.0% of the total costs. The reason for this change was the introduction of tractors in the mid 70`s compared to the use of oxen in the 40`s. In the twenty-first century the drastic decline in the area planted was due to increasing costs of operation which therefore led to a reduction in the number of farmers and then land planted (Liebenberg *et al*, 2010).

4. Literature review on agricultural productivity

4. 1 Research methodologies

Agricultural productivity is measured as the ratio of agricultural outputs to agricultural inputs. Its measures are subdivided into partial, multifactor and total. Partial factor productivity is the amount of output per unit of a particular input. It only considers a single input in the ratio. For example, it uses yields of crops to determine the productivity of field crops. Literature indicates that it is easy to compute as it requires limited data, but it can be hard to identify factors that cause productivity of field crops to change.

Both Multifactor productivity (MFP) and Total factor productivity (TFP) are defined as the ratio of total agricultural output to a subset of agricultural inputs. They utilise more than a single factor. Their measures reflect the joint effects of many factors including new technologies, economies of scale, managerial skill, and changes in the organization of production to agricultural production.

TFP is preferred to MFP due to that fact that it captures the full extent of input use and output production. But due to the fact that it has proved to be a difficult method to use (OECD productivity manual, 2001) MFP is thus used as an approximation of TFP. Although the definitions of both these methodologies reflect the use of output and input quantity, in reality using general total amounts is not an option. This is mainly because it is hard to aggregate different quantities of different measurements (mass vs. volume). And even if the output and inputs can be aggregated with the hope of deflating them, this will lead to a situation where relative price ratios to that of the base year are distorted.

As a result the use of indices in these methodologies are highly encouraged and preferred. There are various types of indices. This includes the Laspeyres, Tornqvist-Theil, Paasche, Malmquist and Fisher indexing methods. Laspeyres

indexing method is a weighted base index and cannot be used in productivity analysis as it distorts the relative price ratios. It is usually used for computing the consumer price index. Tornqvist-Theil indexing method is a chained Divisia index and uses spliced price and quantity indices of Laspeyres type as a proxy for prices. But it is seen as not an ideal method as it involves use of logs, which is impossible when the values turn negative as is the case with inventory changes and requires aggregation of data when commodities/inputs come into use at a later stage than the base year. The Fisher indexing method is the most preferred by many OECD countries, as it does not require the taking of logs and aggregation of the underlying data when inputs/commodities come into use at the later stage than the base year (Liebenberg *et al*, 2010). South Africa so far has been using the Tornqvist-Theil indexing method.

4.2 Review of studies

4.2.1 International studies

There exists quite good literature on the trends of agricultural productivity, factors affecting agricultural productivity and ways to improve agricultural productivity in both developed and developing countries. However, there is dearth of work on the level of agricultural productivity at regional and enterprise level in these countries. Studies on enterprise level productivity specifically are mostly limited to Asian and Central Asian countries.

Literature reviewed showed that agricultural productivity increases more in developed countries compared to less developed countries. This is due to high investment in research and development, labour, land and capital and improvement in the use of inputs such as fertilizer, machinery increases and others. According to Chang *et al* (2010) labour productivity in China increased by 4.13% whilst that of the United States was 7.16% during 1987-1994. In general land productivity is higher in less developed countries as compared to developed countries due to land reform. It must be noted that growth in agricultural

productivity depends primarily on technological change, improved input use efficiency and conservation of natural resources. These in turn, depend crucially upon investments in agricultural research, extension and human capital.

❖ ***Developed Countries***

Grant (2002) estimated agricultural productivity from regional accounts for twenty one regions in 1880/4, 1893/7 and 1905/9 in Germany. The estimates were derived from regional accounts for agricultural production and costs. Results indicated that productivity in East-Elbian agriculture was growing rapidly in the period, and tending to converge on the German average. Productivity in Southern region was not growing so fast, which showed that yield improvements were not limited to large farms and estates, but that smaller holdings also had access to new technology and improved husbandry methods. The main conclusion to emerge from this analysis was that there was a strong process of convergence which brought productivity up in the rural east to level equal to or above the national average. This convergence mechanism was associated with the spread of more advance agricultural techniques.

Chang *et al* (2001) determined how to promote agricultural productivity growth to achieve sustainable food security most efficiently in Asia and the Pacific. The study looked at the role of investment, both in physical and human capital, in maintaining and increasing agricultural productivity. In order to achieve the objectives the study used TFP and partial factor productivity functions. Results indicate that agricultural output growth has remained positive from 1961 to 1994 with only one exception, Japan, compared to a slowdown during 1975-1987 in output and labour productivity growth in Australia and the United States.

❖ ***Developing Countries***

Zepeda (2001) examined agricultural investment and productivity in the context of developing countries. The study used number of models of production growth (index numbers or growth accounting techniques, econometric estimation of production relationships and nonparametric approaches) to measure the change in output, to identify the relative contribution of different inputs to output growth and to identify the Solow residual or output growth not due to increases in inputs. Results show a relatively weak relationship between physical capital and growth, as compared to investment in technology and human capital. Other factors found to be stimulants to growth included; the policy environment, political stability and natural resources degradation.

Various authors support the findings of Zepeda (2001). Fulginiti *et al* (1998) examined changes in agricultural productivity in eighteen developing countries over the period 1961–1985. The study used a nonparametric, output based malmquist index and a parametric variable coefficient Cobb-Douglas production function to examine, whether declining agricultural productivity in less developed countries was due to use of inputs. Econometric analysis indicated that most output growth was imputed to commercial inputs like machinery and fertilizers.

Chavas (2001) analyzed international agricultural productivity using nonparametric methods to estimate productivity indices. The analysis used FAO annual data on agricultural inputs and outputs for twelve developing countries between 1960 and 1994. Technical efficiency indices for time series analysis results suggested that in general the technology of the early 1990s was similar to the one in the early 1960s. This showed that the improvement in agricultural production was not because of technology but because of other inputs such as fertilizer and pesticides. The general empirical results indicated only weak evidence of agricultural technical change and productivity growth both over time

and across countries. There was much evidence of strong productivity growth in agriculture over the last few decades corresponding to changes in inputs

In Asia, Chang *et al* (2001) determined how to promote agricultural productivity growth to achieve sustainable food security. The study looked at the role of investment, both in physical and human capital, in maintaining and increasing agricultural productivity. In order to achieve the objectives the study used TFP and partial factor productivity functions. Results indicated that the only way to promote agricultural productivity was through improving labour productivity. The improvement in labour productivity in China was 0.68% per annum during 1961 to 1975, 4.37% per annum during 1975 to 1987 and 4.13% per annum during 1987 to 1994. The per annum improvement in labour productivity in India during the same periods was 0,2%, 1,07% and 2,04% respectively. The per annum improvement in labour productivity over the period 1961 to 1994 was 7.41% and 7.16% for Japan and Korea respectively. Due to the improvement in labour productivity, the agricultural output growth for these countries, with the exception of Japan, has remained positive from 1961 to 1994. The total factor productivity for China surprisingly remained negative despite its growth in output and partial factor productivity of labour and land. This is because output growth was generated primarily from the expansion of inputs, rather than productivity increases. It is generally accepted that there are ample room for productivity improvements in the less developed countries.

Tripathi *et al* (2008), however, argued that an improvement in not only labour but also capital and land productivity can improve agricultural productivity. They studied agricultural productivity growth in India and the impact of labour, capital and land on agricultural productivity growth from 1967-70 to 2005-06. A Cobb-Douglas production function was used to analyze data and the results indicated that output elasticity of land was 1.98, labour 1.06 and capital 0.15 and when added up they gave a sum greater than one. This meant all inputs had positive and significant influence on agricultural productivity growth.

Velazco (2001) examined trends in agricultural production growth for the period 1950-1995, identified factors that affect agricultural growth and investigated any underlying constraints. The study used a Cobb-Douglas production function and supply function to analyze data. The study looked at how changes in land, labour and fertilizer, the role of public and private investment, technological change, policy and political violence influenced Peru's agricultural sector. A specific outcome of the agricultural growth estimation of the aggregate production function for 1970-1995 indicated that increasing agricultural employment would have the greatest impact on the output, followed by land, fertilizer and tractors. The general conclusion was that public and private investment was required to increase agricultural production. There is a relationship between public and private investment with the latter responding to increases in the former. However, it must be noted that land is still concentrated in larger holdings. Only few people have large farms, while a large group of the population has small holdings and little or no education. The implication is that investment in human capital appears to be an obstacle to the effectiveness of extension programmes and technological change. Improved inputs are only used in the coastal region where the large holdings are concentrated. The demand for tractors and agricultural machinery is also concentrated in the coastal region. A specific observation was that agricultural investment has been adversely affected by high inflation, the external debt crisis and hence lower availability of funds, as well as political violence.

Kiani *et al* (2008) measured total factor productivity in the crops sub-sector and analyzed the relationship between productivity and agricultural research expenditures during 1970-2004 in Pakistan. They used Tornqvist-Theil index method for measuring total factor productivity using outputs and inputs for 24 fields and horticulture crops. Results indicated that total factor productivity index for crops sub-sector improved over time, at an average annual growth rate of 2.2%. The reason for this improvement was the growth in productivity over the

previous 35 years. The general conclusion drawn was that investment in agricultural research played an important part in productivity growth. Mechanization and development of roads infrastructure also had a positive significant effect on total factor productivity.

❖ **4.2.2 Studies in Africa and South Africa.**

❖ **Studies in Africa**

According to estimates from Conradie *et al* (2010b) rates of MFP growth in Africa are generally low compared with those for other countries in the world. Within Africa itself the level of MFP differs. Ajao (2008) examined changes in agricultural productivity in Sub-Sahara Africa (SSA) countries for the period of 1961-2003 in the context of diverse institutional arrangements using Data Envelopment Analysis (DEA) The , DEA method was used to measure Malmquit index of total factor productivity. A decomposition of TFP measures assessed whether the performance of factor productivity was due to technological or technical efficiency change, and the study further examined the effect of other variables (land quality, malaria, education, control of corruption and government effectiveness).

Results indicated that Burkina Faso, Cote d'Ivoire, Kenya and Djibouti were the four countries with the highest TFP growth; the findings further revealed that Lesotho, Sierra-Leone and Swaziland had negative TFP growth, which was due to decline in the technical efficiency. The average TFP growth over the whole period was 1.8% per annum. The observed increase in the TFP was due to technological change rather than technical efficiency change, since efficiency change decreased by 0.06% while the technological change increased on average by 2.3% during the reference period. It was observed that all variables included in the model had significant impact on the TFP except government effectiveness.

Kibaara *et al* (2008) analyzed trends in agricultural productivity using a nationwide household panel survey in Kenya. The study examined productivity changes for maize, tea, coffee, sugarcane, cabbages, Irish potatoes and dairy. The study used descriptive analysis to show trends in partial productivity and a Cobb-Douglas production function was used for productivity analysis. Results showed an impressive growth in maize and dairy sub sector productivity, maize growth was due to increased percentage of smallholder households using fertilizer, adoption of improved seeds and the availability of fertilizer retail outlets. Dairy sub sector growth was mainly due to increased investment in dairy production and production of fodder crops. Sugarcane and coffee productivity declined mainly due to management challenges. Cabbage and Irish potato productivity fluctuated over the panel period, and did not show any meaningful trend. In general, Kenyan agricultural productivity appears to be rising. It has been found that in order to sustain productivity growth and encourage farmers to increase production and productivity of major enterprises, farmers will require an improvement in innovative financial services.

In there study on “Agricultural policy, Investment and Productivity in sub-Sahara Africa (SSA)”, Wiebe *et al* (2001) indicated that an expected increase in output from improved infrastructure and price policies were difficult to quantify, but such improvements were probably prerequisites to make possible the increases in productivity from the use of conventional inputs and research. Other important constraints to agricultural productivity were the quality and availability of education, research and extension services, as well as institutional uncertainties that weaken incentives to invest in the maintenance or improved of land quality. The study concluded that education of rural labour force and agricultural research is needed to improve the future prospects for productivity growth in SSA. That being the case agricultural production has been increasing in SSA at over 2% per year in recent years. Land productivity increased by an average of 1.9% between 1950 and 1993 (and labour productivity declined by an average annual rate of 1.0% between 1980 and 1995). Levels of physical capital,

livestock, fertilizer, and non-conventional inputs have also changed, contributing to an estimated 11.3% annual increase in total factor productivity between 1961 and 1991. Further analysis projects that food production in SSA would have to grow at a rate of 3.3% to 4.5% annually to maintain per capita consumption levels or meet nutritional requirements over the next decade.

Wiebe *et al*, (2001) examined the impact of agricultural policies and investment on productivity in sub-Saharan Africa especially in Zimbabwe and South Africa. The study compared the effects of agricultural policies and investments on commercial and smallholder agriculture using previous studies. Results indicated that land productivity grew in both countries. In Zimbabwe it increased by an average of 1.3% and in South Africa it increased by an average of 0.6% per year. Labour productivity increased in South Africa by an average of 1.3% while it decreased by 0.7% in Zimbabwe per year. In both countries previous government interventions favoured European farmers over African farmers. Total factor productivity (TFP) growth for commercial sector in Zimbabwe was at about 4.0% in the 1970s and 1980s and in South Africa it grew by 1.3% between 1947 and 1991, accelerating to 2.9% in the final decade leading to independence. TFP in Zimbabwe's communal sector grew by 8.1% in the early 1980s and fell by 2.7% since there was a reduced in spending for costly post-independence policies supporting smallholder production. Commercial agriculture in South Africa, demonstrates the potential benefits of investment in infrastructure, human capital and research.

❖ **Studies in South Africa**

The first TFP study in South Africa was done by Thirtle, Sartorius von Bach and Van Zyl in 1993. The study focused on the productivity of commercial sector as data on small scale farmers was not available in the Census of Statistics Department. According to these authors TFP grew at an average rate of 1.3 per cent per annum from 1947-1991. This was mainly due to reduction in the cost of

labour input as it was abundant and cheap. In these years tax concessions and credit policies made labour cheap and capital more expensive. As a result such changes led to the growth of productivity together with increasing employment, which must have improved social welfare. Following this study, Kirsten and Vink in 2003 analyzed TFP for the period between 1947-1996.

Their study showed that on average there was an increase in productivity of the sector due to increasing inputs use and output. However they further mentioned that TFP increased at a declining rate since 1960 to 1996. In 1960 TFP was 2.05 whereas in 1996 was 1.6. The reason for such fluctuation was due to increase in the value of capital which made labour cheap, deregulation of markets and increase in inflation rates which made inputs expensive. A study conducted by Thirtle, Piesse and Gouse in 2005, which updated on the study of Thirtle, Helmke Sartorius von Bach and Van Zyl (1993), concurred with the findings of Kirsten and Vink (2003). The results of their study showed that between 1993 and 1999 TFP had been fluctuating. In 2009 Conradie, Piesse and Thirtle compared the level of aggregating statistics for calculating productivity at district, regional and national level using data from Western Cape Province for the years 1952-2002.

They found that over these five decades agricultural production in the province grew twice as fast as in the country but varied per region. In the Karoo growth of productivity was negative whereas in Boland and Breed River Valley it grew above 2%. This was due to the fact that Boland and the Breede had extensive irrigation. The study also showed that national estimates are not giving precise picture of productivity but provincial, regional and magisterial can show such level of details. Regional analyses show a particular enterprise, so that one can deduce whether field crops or animal are more productive. It has been found at regions that field crops and horticulture have more growth than animal rearing.

Poonyth, Hassaan, Kirsten and Calcaterra (2001) stated that agricultural productivity is less than productivity of non-agricultural sector. However, the growth of productivity of agriculture overtime is important for rural development and growth of other sectors in the economy. Thus, other sectors depend on agriculture for inputs and therefore if productivity of agriculture declines this will automatically mean the productivity of other sector will decline.

In 2010, Liebenberg *et al*, studied South African agricultural production and productivity patterns. They documented and discussed developments regarding aggregate inputs, output and productivity. They found that agricultural output growth had lagged behind the rest of Africa in recent decades. Composition of output had also changed, with higher-valued horticultural crops gaining market share at the expense of staple crops and livestock products. The composition of inputs use had changed too. There was a substantial increase in the use of material inputs and capital inputs while the use of labour had declined. Results indicated that land productivity grew at an average rate of 2.49% per year from 1911 to 2008, slightly slower than the corresponding rate of labour productivity growth, which averaged at 2.83% per year. Multifactor productivity (MFP) grew by 1.49% on average per year from 1947 to 2008. MFP was stagnant during 1989 to 2008, owing to a decline in the rate of output growth couple with an increase in the rate of input use in agriculture. With the evidence presented, investments and the incentive structures that affect agricultural research and development were suggested to can better the situation.

5. Data needed and gaps

Databases used for productivity measurements involve output and input indices. Such data should cover lag time of 24 to 50 years for more desirable results. Alston *et al* (2010) also indicated that year-on-year changes in productivity trends were completely inadequate to pass judgment on whether a trend break had actually occurred. A worldwide database in output and input indices is available.

OECD countries such as USA, Canada and Australia have for many years mastered the collection and compilation of such data at national level.

Even South Africa has such data. A database used for productivity measurement resides with the Department of Agriculture, Forestry and Fisheries. Collection of data particularly of detailed expenditure on capital and intermediate inputs used started between 1947 and 1953. It was originally compiled from departmental records in 1993. Variables included in the database come directly from various production and national income accounts maintained by the Directorate of Agricultural Statistics which is published under the Abstract of Agricultural Statistics. Other information comes from Agricultural Census Reports compiled by Statistics South Africa. It is important to note that the lag time in South Africa is 14 years

Within Abstract of Agricultural Statistics the data available are:

- Total output of agriculture at national level
- Total input of agriculture at national level
- Total output of agriculture at provincial level
- Total input of agriculture at provincial level
- Total output of agriculture per enterprise (field crop, animal and horticulture)
- Indices of total output of agriculture at national level
- Indices of total input of agriculture at national level

Database used for productivity estimates at provincial and district levels are not readily available in some parts of the world. In developed countries, database is constructed from district level and then aggregated to provincial level through to national level. Only a few countries in the developing world construct data at district level. Countries in Asia and Central Asia (in particular in India) create a comprehensive and detailed on-farm database on production and input use. South Africa does have a very limited database at district level and provincial

level. The available database at district level resides with Statistics South Africa and was collected and published in detail prior to 1988. Since 1988 it is published in summary form and access to detailed data is difficult and in most cases unsuccessful.

District level disaggregation enables researchers to conduct analysis with respect to evaluating technology policy, benefits of improved market access through investments and infrastructure, etc. Aggregation of physical units is simply not interchangeable unless converted to some common physical equivalent (Block, 1994). This is so because there is a problem in measuring output due to the following reasons: mixed cropping is common; crop by-products are not enumerated; crops are consumed at home or as inputs to other household production activities; or farmers have diversified into new products that are poorly enumerated in national surveys. On the input side, little data are available on small capital investments such as implements and land improvements, especially the value of family labour in land improvements (Zepeda, 2001).

6. Summary of findings

Findings of this report reveal that there is abundant knowledge on productivity of the agricultural sector, factors affecting it and ways to improve in both developed and developing countries. Even so agricultural productivity of developed countries is increasing more than that of developing countries over time. This was because there are more investment and research on inputs use, capital, land and labour productivity in the developed countries compared to developing countries. Literature indicated that efficient input use, technological investment, improvement in the productivity of labour, land and capital and conservation of natural and environmental resources were vital to improve on productivity of the sector.

In South Africa in particular productivity of the sector nationally has been stagnant since the twenty-first century. This poses several challenges particularly because the level of unemployment is increasing and food insecurity is a concerning issue. But literature points to a potential improvement in the productivity in developing countries which is posed to measure up to the increasing population, increasing unemployment and improves the nutrient intake level per capita.

Various limitations were however highlighted in the review which include (a) limited number of studies at both district and provincial areas worldwide (studies on district productivity level are limited to Asia and Central Asia); (b) aggregated district level data (StatsSA aggregated district level data since 1988); (c) lack of disaggregation of data at district and provincial level (d) limited use of Fisher index method in estimating productivity which is the most preferred method as it does not use logs and aggregation (South Africa instead uses Tornqvist-Theil indexing method which use logs making it difficult if the value is negative) and limited involvement of governments in researching and compiling a database on productivity estimates (Estimating productivity is done at research institution level whilst poly instruments and support at government (DAFF) level in South Africa).

7. Conclusions and recommendations

The purpose of productivity analysis goes much further than just to measure performance and efficiency. The analysis also is important for the following:

(a) Gauging the sources of growth, be that investment in research, improved market access, efficiency gains, technological progress or others.

(b) Gaining insight into the extent to which policy changes on resources use have had influence on resource use, and

(c) Analysing the effect that policy changes have had on the performance of the sector.

As such having the involvement of DAFF in productivity estimates is vital. This study therefore recommends the following plan of action:

- Identify research institutions involved in productivity estimates and create collaborative consortia to gain access to data sources. This process will require careful negotiation to ensure mutual benefit and it will help DAFF to determine whether it should get involved or just buy the finished reports produced by individual organization.
- Look into the possibility of outsourcing some research activity on productivity estimates that will encourage building of capacity with DAFF. This will require DAFF to define the extent to which it should be involved in research either through financial support or through building long-term and sustainable capacity within employees or just forging a long-term relationship with research institutes.
- Agree on how detailed and comprehensive on-farm data should be collected and compiled. This will require forging a relationship with StatsSA as to get access to detailed district level data
- Adopt a standard methodology for analyzing productivity. This will include the type of index method to be used, lag time period of analysis (already we have a 14 years analysis time period is it worth it), interval for estimating productivity (year-on-year is advisable, perhaps five years)

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