Critique of
"Agriculture and Technical Change"
F.H Gruen, JPE 43(1961)

For

Dr Bruce Gardner

Dean, College of Agriculture and Natural Resources

University of Maryland

By

Joshua Ariga

Tegemeo Institute / Egerton University

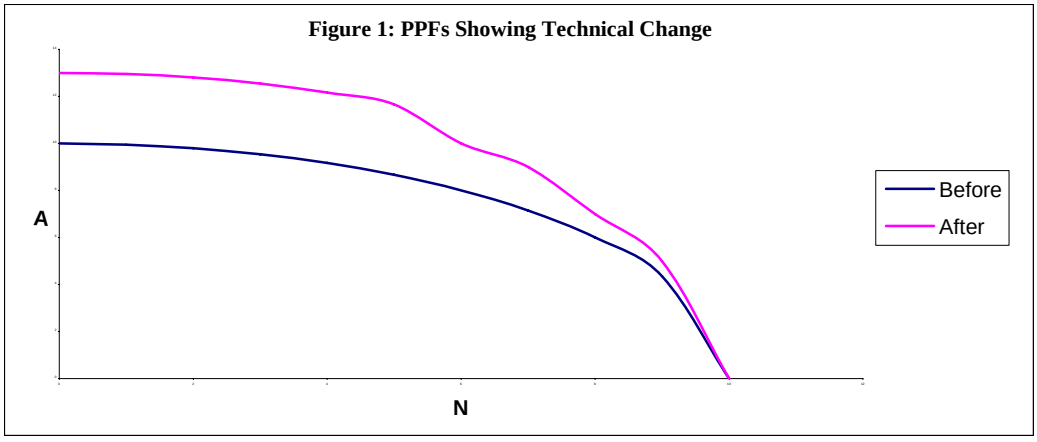
Table of Contents

1.0 Synopsis of the Article

The article looks at technical change using a two-product model involving agricultural (A) and non-agricultural (N) output for an economy. The author makes four crucial assumptions; technical change affects the production of A only, it is a neutral change (non-saving in any input), the economy is closed (no international trade), and no adjustments allowed so as to enable static analysis. The basic model of the article can be explained by using the concept of production possibility frontier (PPF) for A and N shown in Figure 1 below.

A PPF gives a locus of product combinations of A and N within given resource levels. The optimal combination occurs when the marginal rate of transformation (MRT) equals the relative prices. The assumption of neutral change implies that the production function of $A = f(x_1, ..., x_n)$ becomes $A = \lambda f(x_1, ..., x_n)$ after the technical change at the old input mix levels where $\lambda > 1$. This implies that marginal products of all factors are scaled equally by the change.

Figure 1: PPFs Showing Technical Change



After the change relative prices have to change otherwise less of N will be produced i.e. the marginal rate of transformation of N for A ($MRT_{A,N}$) increases with technical change. What Gruen calls the expansion effect raises output of A while the substitution effect leads to a subsequent decrease in A and increase in N, akin to Hicksian income and substitution effects. Reduction in A occurs if the elasticity of demand for A is less than unity leading to the substitution effect exceeding the expansion effect. When international trade is introduced there exists a possibility of "immiserising" growth where

technical change in the innovating country leads to less volume of goods available for consumption in that country.

2.0 Other Related Literature

A lot of work has been done on economic benefits of technical change by a legion of authors over the years since the above article was published. There is almost unanimous agreement on the importance of technical change to economic growth (e.g. Solow (1957)). Technical change is often described as (i) a creation of new knowledge and technology and (ii) the adoption of new technology by firms (Chavas (1995)). There is usually a lag between R&D investment and the adoption of new technology. In most cases, knowledge/technology has characteristics of a public good and thus public funding for R&D is the norm for basic research with private investment occurring only where applied research payoffs are short-lived and rights can be patented.

In theory technical change leads to increased output at the original input levels or use of fewer resources to produce same output levels as before the change, thus reducing resource scarcity (Hicks (1932)). This is what a number of authors dub “induced innovation” that leads to use of fewer resources. Binswanger (1974) and Ruttan (1978) suggest that the induced innovation hypothesis is usually formulated in terms of biased technical change either against a particular factor (factor saving) when this factor’s relative price increase or towards/in favor of a factor (factor using) when the factor’s relative price declines. Binswanger (1974) and Hayami and Ruttan (1985) found empirical evidence in support of this hypothesis. The latter also found that hybrid seed and fertilizer tend to be yield increasing, acting like substitutes for land (land saving in the Hicksian (1932) sense).

van Tongeren and van Meijl (1998) use nonparametric estimation to evaluate endogenous or embodied technology spillovers and biased technical change in agriculture where the innovation is embodied in a good that is exported from one country to another. The role of institutional set-up in innovation cannot be underrated. US agricultural production and factor productivity have increased since the New Deal of the 1930s due to institutional framework that was set up to conduct research and also to make policy that reduced risk and uncertainty for millions of farmers and related agribusinesses (Farell and

Runge (1983) through emergency relief, research activity, and subsidies to research and extension. Over the years the US policy has protected and aided producers to withstand variable prices and output. Commodity price programs stabilized prices for farmers allowing them to invest in new and improved technologies.

Newbery (1992) makes a case for investing in agricultural infrastructure (roads, irrigation, research extension) because aggregate agricultural supply is responsive to infrastructure but inelastic to price. The Green Revolution increased agricultural production by public investment in plant breeding and other public-good research. Binswanger (1989) shows that supply responses to infrastructural investment are significant. Antle (1988) finds that rural road density has a strong effect on demand for agricultural inputs, which in turn affect output. Increased agricultural infrastructure is akin to land-augmenting technical change having effects on supply like those attributable to raising the supply of land. Newbery (1992) finds that this lowers prices and raises real incomes.

3.0 Limitations of the Gruen Article

The article is very striking in its scientific approach and enlightening considering that it was written close to 40 years ago. The depth of theoretical coverage and mathematical complexity is quite impressive though very unwieldy in its technical terminology. The notation or symbols are also confusing and one is left with the feeling that some simplification and less obfuscation and generalization were possible.

Though the article deals with neutral technical change, technical change is often biased and leads to substitution of one input for another therefore changing the old input mix. In addition, technical change is a continuing process that requires dynamic rather than static analysis. The paper also introduces technical change as an autonomous variable in the production function but technical change can be embodied in a good.

Technical change can also affect both outputs simultaneously something that the author does not delve into in detail. The author fails to give explicit incidences of how actually technical change may occur or be caused to occur and does not deal with the wider perception of technical change as something encompassing effects of input technology as well as nebulous indirect effects as suggested by Newberry (1992)

4.0 References

Gruen, F. “Agriculture and Technical Change,” *Journal of Farm Economics* 43(1961): 838-858.

Farell, K. R and Runge C. F “Institutional Innovation and Technical Change in American Agriculture: The Role of the New Deal,” *American Agricultural Economics Association* (1993).

Chavas, J-P, Aliber, M, and Cox T.L “An Analysis of the Source and Nature of Technical Change: The Case of U.S. Agriculture,” MIT (1997).

Meijl, H.V, and Tongeren, F.V “Endogenous International Technology Spillovers and Biased Technical Change in Agriculture,” *Economic System Research* 11(1)(1999).

Newbery, D.M. “Agricultural Pricing and Public Investment,” *Journal of Public Economics* 47(1992): 253-271.

Antle, J.M., “Infrastructure and Aggregate Agricultural Productivity: International Evidence,” *Economic Development and Cultural Change* 31(1988): 609-620.

Binswanger, H.P., “The Measurement of Technical Change Biases with Many Factors of Production,” *American Economic Review* 64(1974): 964-976.

Binswanger, H.P., and Ruttan, V.W., “Induced Innovation: technology, Institutions, and Development”, John Hopkins University Press, 1978.

Hicks, J.R, “The Theory of Wages” London Macmillan, 1932.

Solow, R.M., “Technical Change and the Aggregate Production Function,” this Review 39(1957): 312-320.