

Master's Thesis in General Management

Finance

International Finance

Hedging agricultural commodities in order to sustain economic growth of underdeveloped areas

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Summary

The key role of Agriculture in developing areas is an engine for growth and what we want to do is to push the concept of agriculture as a starting point for bringing the economy back to the old notion of market: a place where you know what you are buying. Is it impossible to achieve the real growth when there are different levels of development in the same land.

CHAPTER 1: THE ROLE OF AGRICULTURE IN DEVELOPMENT AND THE POVERTY TRAP

1.1 The Role of Agriculture in Development

Today 1 billion people live on less than \$1 per day; the per capita income in the World's richest Country is about 35 times the per capita income in the poorest. Approximately three quarters of the poorest people in the World live in rural areas and, over half of them depend on agriculture or agricultural labour as their primary livelihood strategy (International Fund for Agricultural Development 2001).

Classical theorists, led by Arthur Lewis in the 1950s, viewed economic development as a growth process of relocating factors of production, especially labour, from an agricultural sector, characterized by low productivity and traditional technologies, to a modern industrial sector with higher productivity. The contribution of agriculture to development was passive. Agriculture acted more as a source of food and labour than a source of growth. Although passive, agricultural growth was still seen as necessary for successful economic transformation for two reasons:

- (1) to ensure the supply of food and prevent rising food prices and real wages from undermining industrial development;
- (2) to utilize a major natural resource—land—as an additional “free” source of growth that would not compete with resources for industrial growth (Lewis 1954).

1.2 The Poverty Trap

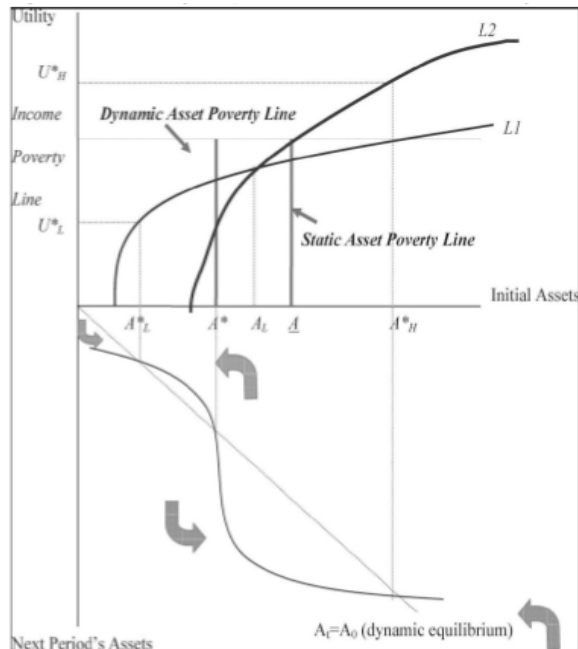
The definition for *conditional convergence* states that if countries possess the same technological possibilities and population growth rates but differ in savings propensities and initial capital-labor ratio, then there should still be convergence to the *same* growth rate, but just not necessarily at the same capital-labour ratio. Using Social Accounting Matrices for 27 countries, Vogel (1994) examined the strength of the linkages between agriculture and rest of the economy at different development stages. At early stages of development, the backward linkages were very strong, while the forward linkages were much weaker. Rising household incomes represented almost 70 percent of the backward linkages. Along the development path, the forward input-output linkage strengthened due to the greater integration of the sector into the broader economy.

In the last year (from January 1998 to November 2010) Mexico GDP Value grew at 3.22% India at 8.80%, China at 9.60%, while United States grew at 2% and Europe has grown with an average of 1% (www.tradingeconomics.com). This is due to the fact that those developing Countries adopted different policies for the private savings, investment and at the macroeconomic level, but it can confirm that they are converging (maybe in 20 years) to the more industrialized Countries. This kind of process can be stopped by the risk exposure of the Developing Countries. In particular the risk of shocks can shift one Country from a growing path to another, it adds noises to conditional convergence; for example risk leaves lenders vulnerable to default by borrowers; this limits access to credit especially for poor people who lack collateral to guarantee loan repayment. The combination of conservative portfolio choice induced by risk aversion, and credit market exclusion because risk exposure dampens lenders' willingness to lend,, help perpetuate poverty. This downward spiral is also generated by the measures taken by the people from poor countries: they adopt low-risk strategy (low investment) and the obvious result is a low - return with difficulties in the asset accumulation and consequently difficulties in climbing out of poverty. We can define *poverty trap* as any self-reinforcing mechanism that causes poverty to persist.

Costas Azariadis introduces one more model of poverty trap: *the Threshold Model of Poverty*. "An initially high level of poverty and low life expectancy may change the way an economy works because it may make the return to incremental changes in capital small or even negative" (Steve Bowles, 2006). The theory is based on the concept that poor economies cannot produce the levels of human and physical capital

to exceed the threshold necessary for achieving a certain type of economic organization.

In order to give a picture of the mechanism that circumscribes people into poverty, we will use a model developed by Carter and Barrett (2006) who tested their model in the agrarian society with success.



The model starting from the conception that an asset accumulation process is what allows convergence to the high stable equilibrium and the improvement in welfare (Barrett, 2007); demonstrates that the poorer households cannot accumulate assets. They explain that poorer households cannot accumulate assets due to their portfolio choices. They would adopt a defensive portfolio strategy, preferring low-yield, low-risk activities rather than higher-yield, higher-risk activities. This is due to the fact that they are involved in risk of many types, starting from credit risk and going through all the risks that affect the rural environment, where the poorer are more concentrated. Improving the productivity of agriculture is the single most important step a developing country can take to reduce poverty.

CHAPTER 2: RISK IN AGRICULTURE: ANALYSIS AND MANAGEMENT

Agriculture is an inherently risky economic activity. A large array of uncontrollable elements can affect output production and prices, resulting in highly variable economic returns to farm households. In developing countries, farmers also lack

access to both modern instruments of risk management—such as agricultural insurance, futures contracts, or guarantee funds—and ex post emergency government assistance. Analyzing the many components of Agricultural risk we can recognize five different main kind of risk:

Production Risk: is the random variability inherent in a farm's production process. Weather, diseases, and pest infestations lead to production risk in crop and livestock activities.

Market or Price Risk: is associated with the purchase of inputs as well as the sale of commodities. Fluctuations in input and output prices cause income gains or losses.

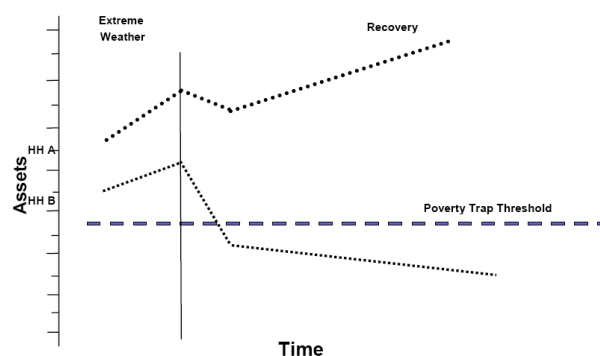
Financial Risk: is the risk related to the financial health of the farm. Market imperfections and asymmetry of information make the market for credit, for the Agricultural sector, really difficult to penetrate. This generates liquidity problems for the farmers that are pushed to choose low risk/low revenue strategy.

Institutional Risk: Institutional risk results from uncertainties surrounding government actions.

Human or personal risk: refers to factors such as problems with human health or personal relationships that can affect the farm business.

2.1 Weather risk

Recent evidence and predictions indicate that climate changes are accelerating. The changes in the mean and the variance of rainfall and temperature, brings the farmers in the uncertainty of his outcome. Moreover climate events can result irreversible and generate huge losses of capital following the increasing market fluctuations (increasing in Oil and food price volatility). This will cause **poverty traps**. Many business, including agriculture, insurance, energy, and tourism are strongly affected by the weather risk and the financial markets have devised a new class of instruments in order to reduce the risk exposure to the weather.



Some successful policy for managing weather risks and improves hedging for production risk as a whole can be divided in:

Social Protection

Microfinance

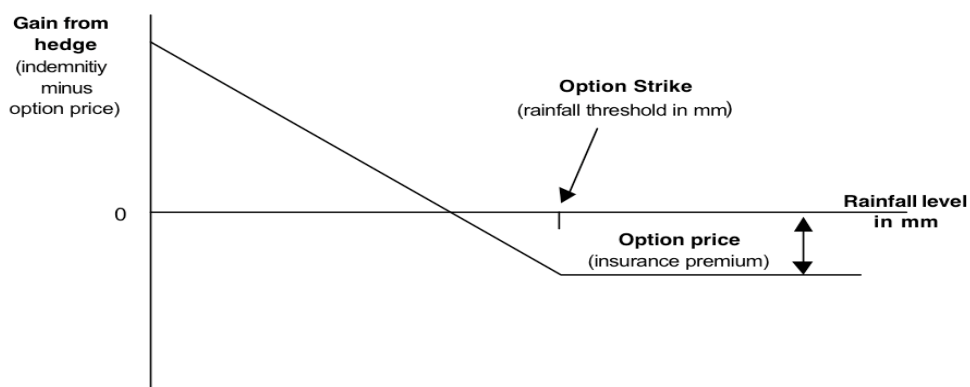
Credit market imperfections can create inefficiencies in production, consumption and investment and this affect most of all the poor rural areas. Microfinance is based on social intermediation between poor people and their savings with the aim of creating self-employment and reduce poverty. NABARD (National Bank for Agriculture & Rural Development) defines “micro-finance as the provision of thrift, saving, credit and financial services and products of very small amounts to the poor in rural, semi-urban and urban areas for enabling them to raise their income levels and improve their standard of living”.

Weather Based Index Insurance

Weather index insurance pays indemnities based on realizations of a weather index that is highly correlated with the actual losses. Weather derivative are written on weather indices, build around an historical analysis on weather data, ideally highly correlated with local yields.

Financial instruments

The variation in crop yield predicted by the index must be converted into a financial equivalent that estimates the effective farmer’s exposure. An example took place in 1995, when the Moroccan Government activated the “Programme Sécheresse”, it was a yield insurance programme connected with rainfall in order to avoid the consequences of severe draught and their strong impact in the Moroccan Agricultural sector. It was an European put option where the option price is the cost of the coverage and the strike is the rainfall threshold below which an indemnity is triggered.



2.2 Price or Market risk

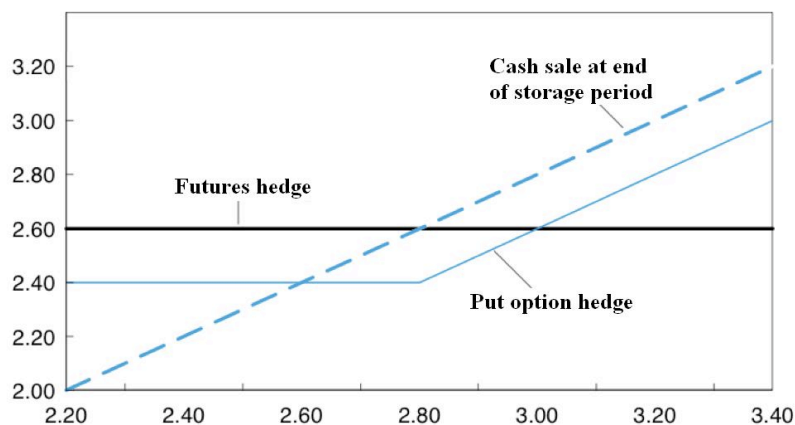
Price volatility significantly impacts the incomes of farmers and the macroeconomic health of their countries. From 1983-1998, the price of many commodities fluctuated from below 50 percent to above 150 percent of their average prices. In order to hedge, two kind of solution are suggested by the financial market:

Hedging price with *futures*

A futures contract is an agreement priced and entered on an exchange, to trade at a specified future time a commodity. The use of features involves shifting risk from a party that desire less risk (the hedger) to a party who is willing to accept the risk in exchange for an expected profit (the speculator).

Hedging price with *futures option contracts*

A future commodity option gives the right, but not the obligation to take a futures position at a specified date. The advantage in this case is represented by the option that gives the change to hedge against adverse price movements. To gain this protection the hedger has to pay a fee (as in the insurance case).



2.3 Financial risk

The availability of liquidity is a lack that depresses accumulation of capital and makes the development difficult and slow.

The willingness of lenders to supply loans now or to continue to supply needed funding in the future is uncertain and volatility in interest rate produces an added risk to borrowing. These risks are largely influenced by greater economic factors and

changes in financial markets mostly out of the individual farmer's control. Production risk (as we already saw) contributes to financial risk, relating directly to cash flows and the ability to secure and repay loans necessary for operation. So, another aspect of financial risk management is *liquidity* that involves the farmer's ability to generate cash quickly and efficiently in order to meet his or her financial obligations (Barry and Baker). In the credit, financial or liquidity risk one of the aspect that really affects agriculture and is the presence of a *collateral*. The market of credit requires information that results to be asymmetric and the transaction costs make them costly. The solution provided is the presence of collateral that pushes poor borrowers out from the market of credit and induce them into a liquidity trap. Coping with financial risk in Agriculture means also try to manage all the other risk a farmer usually face. It is impossible, in fact, to reduce the financial/credit risk without reducing the price and the yield risk. But trying to unbundle the strictly financial risk we can identify some basic strategy that has to be implemented and considered in every plan for hedging agricultural commodities. These are:

- Records
- Self-Liquidating Loans
- Reserves
- Renting/Leasing
- Manage Marketing and Production risk

Assumed that farmers requires better records and needs to analyze better the performances of their activity let's try to focus, in this section the financial ratios that they have to look for.

Critical areas of financial performance	Ratios
<i>Repayment capacity</i>	<ul style="list-style-type: none"> • Term debt and lease coverage ratio (low risk if >150%) • Capital replacement and term debt repayment margin (heavy reliance on outside sources of repayment if ≤0) • Debt payment/Income ratio (low risk if <25%)
<i>Liquidity</i>	<ul style="list-style-type: none"> • Current ratio (low risk >1.50) • Working Capital (the Californian rule: >50% of annual operating expenses)
<i>Solvency and collateral</i>	<ul style="list-style-type: none"> • Debt –to –asset ratio (low risk if <30%) • Equity –to –asset ratio (low risk if >55%)

<i>Profitability</i>	<ul style="list-style-type: none"> • Debt –to –Equity ratio (low risk if <42%) • Operating profit margin ratio (low risk if <25% if it is mostly owned) • Return on asset (good if <5%) • Return on equity
<i>Financial Efficiency</i>	<ul style="list-style-type: none"> • Operating Expenses/Revenue ratio (efficient operation if <65% if it is mostly owned) • Interest expense ratio (good if cost of debt <12%) • Depreciation expense ratio • Asset turnover ratio • Net farm income from operations ratio (higher is better)

CHAPTER 3: THE CASE: OLIVE OIL COOPERATIVE IN THE SOUTH OF ITALY

This analysis deals with the example of a Farmers’ Cooperative for olive oil production in the South of Italy. For centuries the economy of that South Italy region (Puglia) has been focused on agriculture (especially on extra virgin olive oil production). The opening of the economic horizons to global markets has “reshuffled the cards”. The production at the Italian costs has become insufficient to economically sustain that area, so farmers have been exposed to the problems of international trade, without the knowledge required. The risk related to Cooperative’s activity are divided between risk associated with the Agricultural activity and risk associated with the Cooperative’s product commercialization. It’s basically a distinction between yield risk (for hedging agricultural activity) and price combined with financial risks that have to be faced directly by the Cooperative.

3.2 Managing yield risk

The correlation between yield and rainfall of 0.50. That is a good result in terms of dependence of the crop from the weather event in question.

Year	Rainfall weighted	Irrigation costs	Revenues – i.c.
2000	92.36	5280	11460

2001	220.24	4400	22190.2
2002	497.08	2875	34297.2
2003	282.76	4370	21994.8
2004	352.44	3720	39787.2
2005	312.98	3840	35459.4
2006	490.92	3125	29180.1
2007	391.2	3750	35178.5
2008	253.48	4420	13932.8
2009	421.42	3510	22201.4

Considering that irrigation costs accounts for more than 70% on the outcome to retain an year positive (incremental irrigation doesn't mean same yield) we can assume irrigation costs as the main parameter to quantify the losses caused by drought. Assuming €27,000 the average for revenues minus costs for irrigation and 310mm of rainfall in the period described above the strike limit under which the Farmer A incurs in undesirable outcome, we can quantify the losses in €135/mm of rain below 310mm in the considered period.

3.3 Managing Cooperative's risks

The main problems that the Cooperative has to face are in synthesis related to the **price**. As it was proposed in the previous chapter, two paths are recommended to hedge the price of this commodity:

- Futures

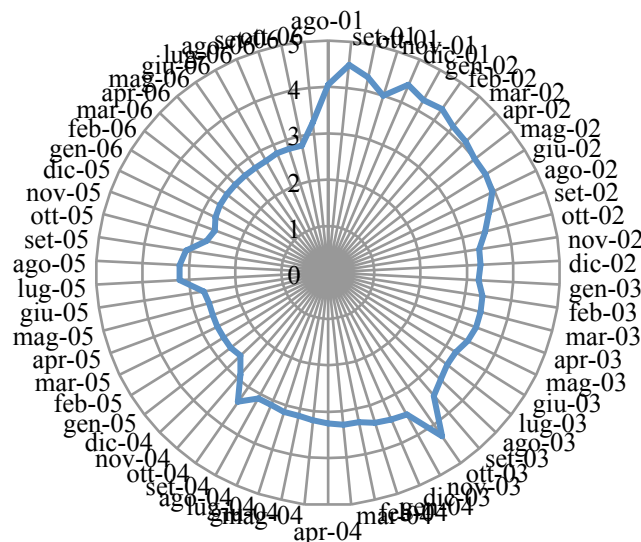
<i>Cash</i>	<i>Futures</i>	<i>Basis</i>
Today: €3.5/l	Sell olive oil contract at €3.8/l	-€0.3/l (under)
Later: sell olive oil in local market at €3.0/l	Buy olive oil contract back at €3.0/l	-€0.0/l
Results	Selling Price €3.0/l Less Commission €0.1/l Plus Futures Gain €0.8/l <hr/> Net selling Price €3.7/l	€0.2/l basis gain

- Futures Option Contracts

<i>Cash and Futures</i>	<i>Option Price</i>
Today: • Cash €3.35/L • Futures €3.40/L	Purchase €3.50/L Put at €0.20/L (pay €1000 plus commission)

Later:	Sell €3.50/L Put at €0.05/L (receive €250 less commission)
	<ul style="list-style-type: none"> • Cash €3.60/L • Futures €3.65/L
Results	- Cash price received €3.60/L - Less commission €0.01/L - Less Option Premium gain €0.15/L <hr/> Net Buying Price €3.44/Kg

All the possible scenarios described above starts from the conception that someone knows where the market is going. From a certain point of view it is right, because historical data, especially in the market for commodities, tend to have a cyclical trend (for example during the year) that indicates the right periods to sell the product.



The price fluctuation analysis can be helpful in a **storage policy** perspective because helps the Cooperative to reach the highest price every year. For example with a right storage policy in 2007 (that is not the highest in terms of spread of prices) that is supposed the Cooperative to sell the 60% of the production in November and the rest of selling spread during the year, the overall outcomes (in revenues) could be €230,000 higher, that represent an incremental income of 16.5% (considering the revenue in 2007). The storage policy of course is strictly correlated with the availability of cash: it becomes possible only if it is sustained by a strong credit risk management policy.

Managing Credit risk

The Cooperative's situation of solvency, presents an equity to asset ratio of 0.85 (remember the benchmark we set is >55%) and a debt to asset ratio of 41% (remember

the benchmark is set to 42%). This gives the banks the capacity to consider the Cooperative as a solvent subject and allow them the access to credit. Banca Carime (in according to the whole Italian Banking System) proposed two different path for giving credit to the Cooperative; fixed rate and floating rate. For the fixed rate the European parameters is the IRS (5 years) and for the Cooperative, that has got an average solvency capacity, was proposed the solution IRS+1, the rate calculated is 7.167%.

Conclusions

The poverty spread in the rural areas testifies the failure in the updating and the development of the agricultural sector. The industrialized countries show a growing unselfishness in the agricultural policies with a progressive detachment from it by the labor force, without considering the fundamental role of agriculture in our lives (just think about nutrition).

Agriculture is a risky sector, difficult to manage, that interfaces with a number of problems with uncertain resolution, first the role of ignorance in the sector's operator.

To upfront the most intractable issues is and has still to be, the main goal of the human challenges; the progress travel through the victory of impossible bets.

Activating a responsibility mechanism by whom knows how to solve problems, against those who has got such problems, evident results can be obtained.

The olive oil Cooperative taken in consideration in this work, in August activated a 10 year loan with floating rate (to upfront the imbalances of cash) and stipulated a futures contract with a multinational reaching the highest price obtained in the last 3 years (for selling in tank in the area considered). This first step toward a sector development results to be a push, even if moral, for those who support economic growth in the area considered (in Sannicandro di Beri over the 40% of the population belongs from olive oil production). The increasing in productivity is the key concept of this paper. It wants to be a food for thought for those who believe that a non-productive activity is destined to remain so.

Bibliography

- *The Green Revolution and the Growth of the Informal Sector in Bangladesh*; [Kirsten Westergaard](#) & Abul Hossain. CRD Working Papers (2006)
- *Weather Risk Management for Agriculture and Agri-Business in Developing Countries*; U.Hess, K.Richter, A.Stoppa. World Bank (2000)
- *An Approach to the Econometric Estimation of Attitudes to Risk in Agriculture*; P.Bardsley and M.Harris. Australian Journal of Agricultural Economics, Vol.31 N.2 (August 1987) pp.112-126
- *Some Issues in Dealing with Risk in Agriculture*; J. Brian Hardaker. Working Paper Series in Agricultural and Resource Economics, No. 2000-3 (March 2000)
- *The Role of Agriculture in Development*; Douglas Gollin, Stephen Parente and Richard Rogerson. American Economic Review (2002)
- *Designing Optimal Crop Revenue Insurance*; Oliver Mahul and Brian D.Wright. American Journal of Agricultural (2003)
- *The use of weather forecast in the pricing of weather derivative*; Stephen Jewson and Rodrigo Caballero. Cambridge University Press (2003)
- *The role of Agriculture in Economic Development*; Johnston and Mellor. American economic review (1961)
- *Operationalising Pro-poor growth. A Country case study in Brazil*; Naércio Menezes-Filho and Ligia Vasconcellos. University of Sao Paulo (2004)
- *Signaling Credit Risk in Agriculture: Implication for Capital Structure Analysis*; Jianmei Zhao, Peter J.Barry and Ani L.Katchova. Journal of Agricultural and Applied Economics, 40,3. Southern Agricultural Economics Association (December 2008) pp.[805-820]
- *Investing in Agricultural Led-growth: The Philippines Case*; James A.Roumasset. Southeast Asian Journal of Agricultural Economics (1992) [pp. 93-70]
- *The Role of Agriculture in Development*; Mukesh Eswaran and Ashok Kotwal. Department of Economics UBC (2004)
- *Uncertainty, Risk Aversion and Risk Management for Agricultural Producers*; Giancarlo Moschini and David A.Hennessy. Handbook of Agricultural Economics. Elsevier (2001)

- *Hedging Price Risk in the Presence of Crop Yield and Revenue Insurance*; Oliver Mahul. Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, St.Louis, Missouri (2002)
- *Poverty traps and Index-Based Risk transfer products*; Barry J.Barnett, Christopher B.Barrett and Jerry R.Skees. World Development. Elsevier (2008)
- *Innovations in Index Insurance for the Poor in Lower-income countries*; Jerry R.Skees. Agricultural and Resource Economics Review (2008)
- *The potential of Weather Index Insurance for a Green Revolution in Africa*; Jerry R.Skees and Benjamin Collier. Global Ag Risk Inc. (2008)
- *Insuring fair prices for farmers in Developing Country – Rabobank International*; World Business Council for Sustainable Development (2004)
- *Agricultural Insurance in Latin-America: Where are we?*; Mark Wenner and Diego Arias. Paving the way Forward for Rural Finance International Conference, Wasington DC (June 2-4,2003)
- *Climate change adaption, Disaster risk reduction and social protection*; Mark Davies, Katy Oswald, Tom Mitchell and Thomas Tanner. Unclassified DCD/DAC (2009)
- *Agricultural Trade Reform and Poverty Reduction: Implications for Sub-Saharan Africa*; Kym Anderson. United Nations Conference on Trade and Development (2004)
- *Poverty Traps and Resource Dynamic in Smallholder Agrarian System*; Christopher B. Barrett. Environment and Natural Resource-Use. Springer (2008)
- *Developing Country Agriculture and the new trade agenda*; Bernard Hoekman and Kym Anderson. Economic Development and Cultural Change. JSTOR (2000)
- *Poverty Traps*; Samuel Bowles, Steven N.Durlauf and Karla Off. Princeton University Press (2006)
- *Rural Finance Services: Implementing the Bank's strategy to Reach the Rural Poor*. Report No. 26030, Washington, DC: World Bank (2003)
- *A National strategy for economic growth and poverty reduction*; Muhammad Yunus. Bangladesh Development Gateway (2008)
- *Fighting Poverty With Microcredit: Experience in Bangladesh*; Khandker, R. Shahidur. World Bank (1998)
- *The Emerging Financial Problems in a Changing Agriculture*; C.B.Baker and J.M.Holcomb. Journal of Farm Economics. JSTOR (1964)
- *Poverty and Opportunity Structure in Rural America*; Ann R.Tikamyer and Cyntia M.Duncan. Annual Review of Sociology (1990), pp 67-86

- *Building Social Capital Through Micro-Finance: A Perspective on the Growth of Micro-Finance Sector with Special Reference to India*; Naresh Singh
- *The use of Price and Weather Risk Management Instruments*; Erin Bryla, Julie Dana, Ulrich Hess and Panos Varangis
- *Poverty Traps*; Costas Azariadis and John Stachursky. Handbook of economic Groth. Elsevier (2005)
- *Microcredit and Agriculture: How to Make it Work*; M.A.Hakim. (2004)
- *Adaption assessment, planning and practice: an overview from the Nairobi Work Programme on impacts, vulnerability and adaption to climate change*; UNFCCC (2010)
- *The Role of Agriculture in Development: implications in Sub-Saharan Africa*; Xinshen Diao, Peter Hazell, Danielle Resnick and James Thrlow. International Food Policy Research Institute (2007)
- *The Potential Role of Weather Market for U.S. Agriculture*; Jerry Skees. The Climate Report (2001)
- *Agricultural Financial Analysis*;
- *Tendenze del Commercio Internazionale dell'olio d'oliva*; Samir Mili e Manuel Rodriguez Zuniga. INEA (2001)
- *Market-Led Versus Government-Facilitated Growth*; Carolyn Dimitri and Lydia Oberholtzer. Economic Research Service/USDA (2005)
- *Agriculture, Rural Development and Pro-Poor Growth: Country experiences in the Post-Reform Era*; Derek Byerlee, Xinshen Diao and Chris Jackson. The International Bank for Reconstruction and Development / World Bank (2005)
- *Addressing Human vulnerability to climate change: towards a "No-regret" approach*; Rasmus Heltberg, Paul Bennet Siegel and Steen Lau Jorgensen. Global Enviromental Change. Elsevier (2009)
- *Developing Index-Based Insurance for Agriculture in Developing Countries*; United Nations Department of Economic and Social Affairs Division for Sustainable Development Policy Integration and Analysis Branch (2007)
- *Evidence on Corporate Hedging Policy*; Shehzad L. Mian. The Journal of Financial and Quantitative Analysis Vol.31, N.3 (September 1996)
- *Coping with Risk in Agriculture*; J.B.Hardacker, R.B.M.Huirne, J.R.Anderson and G.Lien. Elsevier (2004)
- *Testing a Poverly trap mechanism with Tsimane' panel data*; Emilie Perge. Tsimane' Amazonian Panel Study Working Paper #53 (2010)

- *Rural Income Generating Activities: A Cross Country Comparison*; Benjamin Davis, Paul Winters, Gero Carletto, Katia Covarrubias, Esteban Quinones, Alberto Zezza, Kostas Stamoulis, Genny Bonomi and Stefania Di Giuseppe. Working Papers 07-16, Agricultural and Development Economics Division of the Food and Agriculture Organization of the United Nations (FAO - ESA) (2007)
- *Agricultural Insurance: Scope and Limitations for Rural Risk Management*; The commodity risk Management Group, World Bank (2009)
- *Innovations in Rural and Agricultural Finance*; Mark D. Wenner. The World Bank (2010)
- *Macroeconomic policies for conditional convergence*; Michel Aglietta. Presentation of Michel Aglietta (2009)
- *Addressing poverty through local economic and enterprise development: A review of conceptual approaches and practices*; Junior Davis and Catherine Rylance. Natural Resource Institute (2005)
- *Climate-Related Risk in Agriculture*; Renè Gomme. Expert meeting on risk management methods, Toronto. FAO (1998)
- *Government Support to Agricultural Insurance Challenges and Options for Developing Countries*; Olivier Mahul and Charles J. Stutley. The World Bank (2010)
- *Weather risk management for Agriculture and agri-business in Developing countries*; Ulrich Hess, Kasper Richter, Andrea Stoppa (IFC, World Com and Procom Agr, Rome). Climate Risk and Weather Markets. London, Risk Books (2002)
- *Weather derivatives for Specific Event Risk in Agriculture*; Calum G. Turvey. Review of Agricultural Economies. American Agricultural Economic Association (2001)
- *Weather index Insurance for Agriculture and Rural Areas in Lower-Income countries*; Barry J. Barnett and Oliver Mahul. American Journal of Agricultural Economics (2007)
- *Access to Capital and Agrarian Production Organisation*; Mukesh Eswaran, Ashok Kotwal. The Economic Journal, Vol.96 Issue 382 (Jun. 1986)
- *Changing comparative advantage in food and agriculture: Lessons from Mexico*; Irma Adelman and J. Edward Taylor. OECD (1990)
- *Managing Risk in Agriculture*; George F. Partick. NCR Extension Publications NCR-406 (May 1992)
- *Community based adaptation to climate variability and change in agriculture and water resources in the dry tropics of Nicaragua: The Case of San Pedro del Norte*; Carlos J. Perez, Raffaele Vignola and Hernan Perez (2007)

- *Business Tools: Understanding key financial Ratios and Benchmarks*; David Kohl. Northwest Farm Credit Services (2004)
- *Agricultural Development Under a Changing Climate: Opportunities and challenge for Adaption*; Jon Padgham. World Bank (2009)
- *Farmers' Credit Risk and Liquidity Management*; Peter J.Barry, C.B.Baker and Luis R.Sanint. JSTOR (1981)
- *Managing Financial Risk in Agriculture*; Sarah A.Drollette. Utah State University Extension (2009)
- *An Empirical Comparison of alternative Models of the Short-Term Interest Rate*; K.C.Chan, G.Andrew Karolyi, Francis A.Longstaff and Anthony B.Sanders. The Journal of Finance, JSTOR (July 1992)
- *Unspanned Stochastic Volatility: Evidence from Hedging Interest Rate Derivatives*; Haitao Li and Feng Zhao. The Journal of Finance Vol.61, WILEY (February 2006) pp.[341-378]
- *Community based adaption to climate Change Bulletin*; IISD and IIED. International Institute for Sustainable Development (2010)
- *Pricing and Hedging Interest Rate Options*; Anurag Gupta and Marti G.Subrahmanyam. Journal of Banking and Finance 29, ELSEVIER (2005) pp.[701-733]
- *The essentials of rainfall derivatives and insurance*; Calum G. Turvey. Working Paper WP99/06. Department of Agricultural Economic and Business, University of Guelph, Ontario (1999)
- *Addressing Credit and Basis Risk Arising From Hedging Weather-related risk with Weather Derivatives*; Patrick L Brockett, Linda L Golden, Charles C Yang, Hong Z. actuaries.org (2009)
- *European weather derivatives*; N.Buckley, A.Hamilton, J.Harding, N. Roche, N.Ross, E.Sands, R.Skelding, N. Watford, H.Whitlow. General Insurance Convention (2002)

Sources of data:

FAOstat: <http://faostat.fao.org/site/339/default.aspx>

Frantoionline: <http://www.frantoionline.it/news-olio/>

Indexmundi: <http://www.indexmundi.com/>

Borsa Merci Telematica italiana: <http://web.bmti.it/>

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